# SAE Journal

APRIL 1955

IN THIS ISSUE . . .


MEASURING GEAR WEAR by geiger counter .... page 21

FIVE QUESTIONS for aircraft designers to ask themselves ..... page 25

AUTOMATIC CONTROLS will make future automobiles more safe ..... page 44

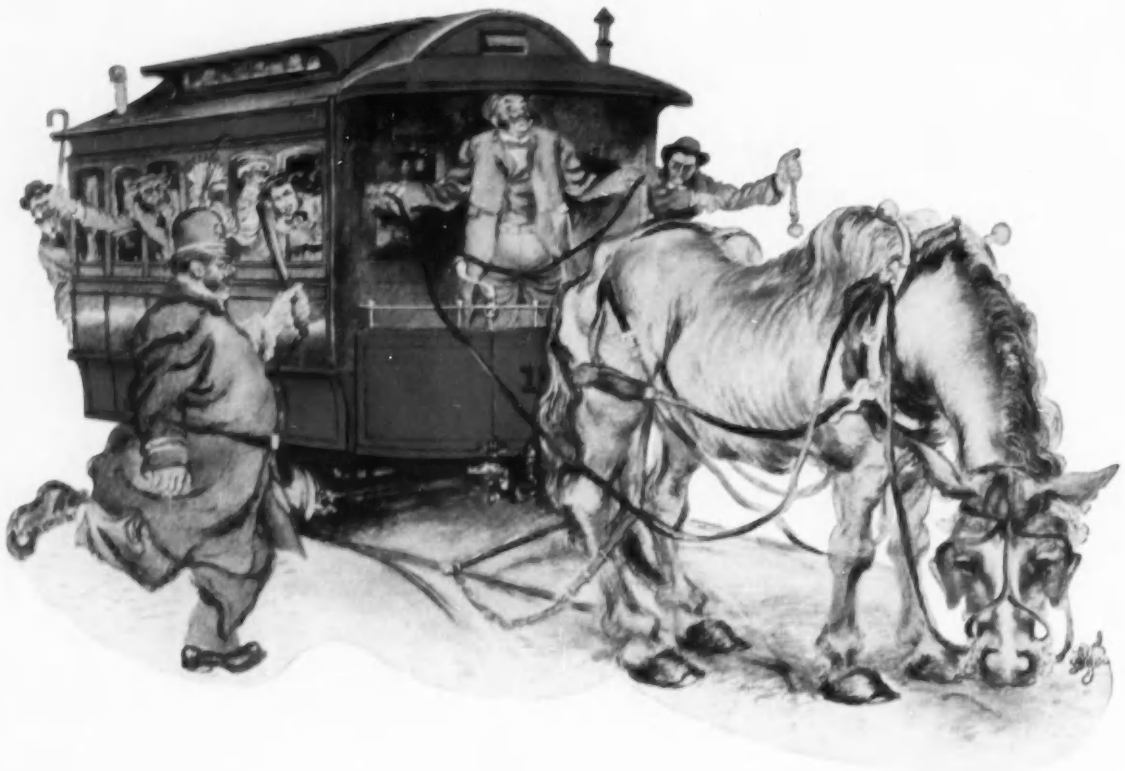
ANALOG COMPUTER can predict automotive suspension behavior ..... page 44

TIMETABLE FOR TURBINE powered aircraft ... page 56

Table of contents on page 15



Published by The Society of Automotive Engineers



## CARS, TRUCKS AND TRACTORS CAN LOSE THEIR HORSEPOWER, TOO!

Engine manufacturers can be proud of the full responsive horsepower they have built into today's engines.

But, those engines can lose their horsepower, too!

Lost Horsepower is costly and aggravating . . . means poor performance . . . excessive oil and fuel consumption.

Chrome piston rings are vitally important in horsepower control. That's why

**35 out of 37 engine manufacturers specifying chrome rings use**

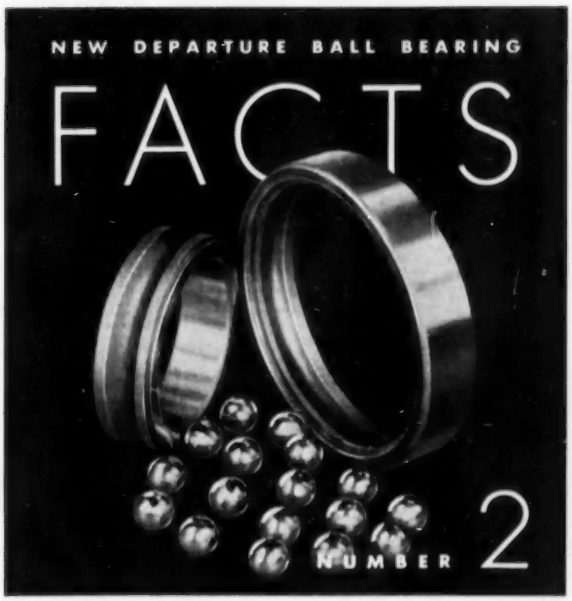
# Perfect Circle

*The Standard of Comparison*

**The application of solid chrome plating to piston rings, as perfected by Perfect Circle, more than doubles the life of pistons, cylinders and rings. Complete performance data will be sent upon request. Perfect Circle Corporation, Hagerstown, Indiana; The Perfect Circle Co., Ltd., Toronto, Ontario.**

# END MAINTENANCE PROBLEMS

## with Bearings "Built to Be Forgotten!"




When machine design calls for bearings in inaccessible places, serious maintenance problems often arise. Disassembly for bearing replacement or adjustment is usually costly in both man-hours and lost production. Much the same holds true for many consumer products that must take use and abuse, yet operate efficiently over long periods.

### BALL BEARINGS THE SOLUTION

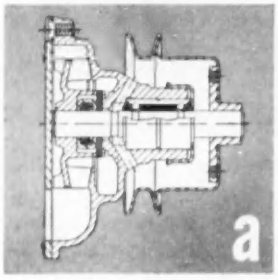
Fortunately, the engineer today has a ready answer at hand. Because of certain unique advantages, ball bearings are ideal in virtually all cases. Ball bearings are permanent, fixed units. When properly enclosed they operate over extremely long periods with practically no wear. Thus, the various parts of the bearing retain their accurate interrelationship. In effect, this means that ball bearings are the most practical of all anti-friction bearings to fit with permanent seals. Lubricant can be enclosed for lifetime operation in many services.

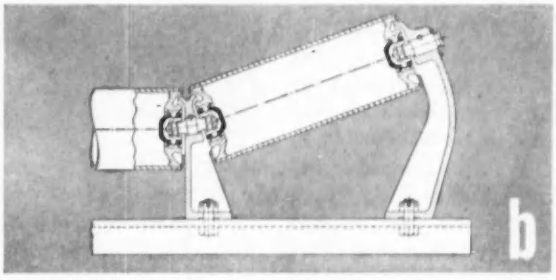
### THE SEALED-FOR-LIFE BEARING

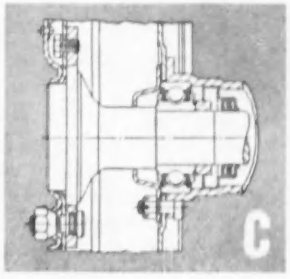
The most logical choice in applications such as those outlined is New Departure Sealed-for-Life bearings. This great advance in bearing design was originated and developed by New Departure. More than 266 million of these bearings have proved their value in service.

In case after case, New Departure Sealed-for-Life bearings have cut maintenance costs to the zero point. Truly, they are *"built to be forgotten"!*

Consult with New Departure on your bearing problems. You will find the experience gained through more than 50 years of designing, testing and manufacturing bearings a major assistance.




**A.** The automotive fan and pump shaft bearing originated by New Departure demonstrates advantages of the sealed-for-life principle. This bearing has eliminated all the old water pump troubles and service. It requires no relubrication or adjustment. It has proved that it is "built to be forgotten," through use in cars and trucks everywhere.

**B.** Conveyor roll units constructed around New Departure conveyor bearings require remarkably few parts. Bearings are sealed and lubricated for life. Savings in labor and lubricant are most pronounced. Units with these bearings are economical to produce and easy for the operator to set up. They also are "built to be forgotten."

**C.** The New Departure rear wheel bearing has made it possible for the engineer to design the simplest, strongest and most foolproof of mountings. This permanently sealed bearing requires no adjustment or relubrication. Grease gun fittings are eliminated. It is famous because it has demonstrated in millions of rear wheels that it needs no attention . . . it can be forgotten.

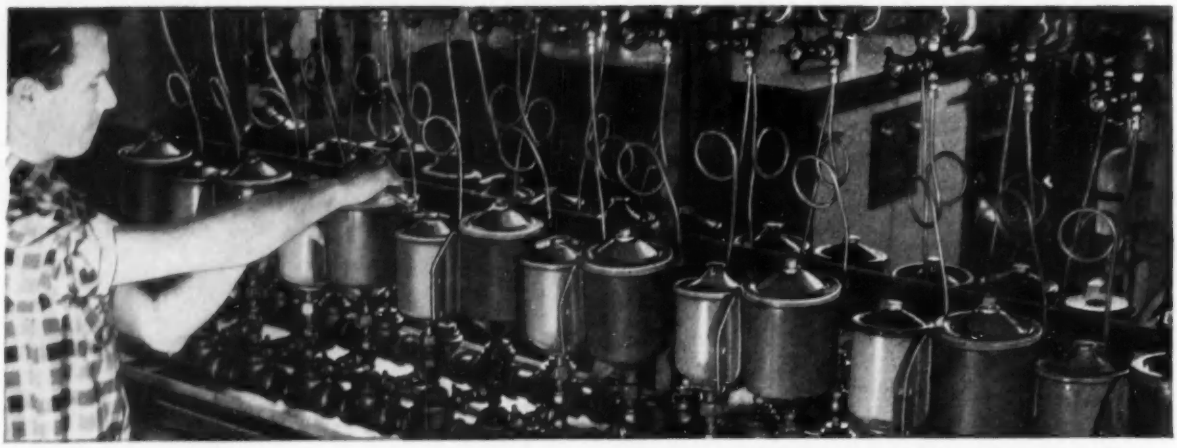
*Send for Booklet D-5 on sealed ball bearings*

NEW DEPARTURE
BALL BEARINGS

NOTHING ROLLS LIKE A BALL

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONN.

# NOW! DAREX *Flowed-in* GASKETS for OIL FILTERS and AIR CLEANERS



*A section of the Dewey and Almy laboratories where* DAREX *"Flowed-in" gaskets for oil filters have been tested to specification: 100 hours at 280°F under 40 lbs. pressure using S.A.E. 20 oil.*

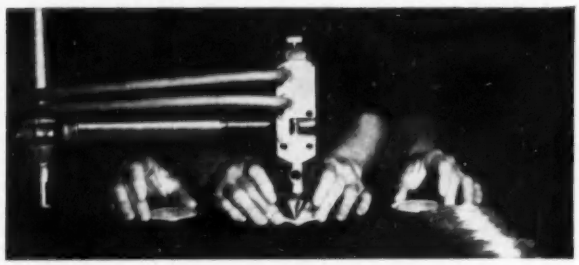
THE SAVINGS in labor and materials that DAREX "Flowed-in" gaskets have brought to other automotive parts are now available to manufacturers of oil filters and air cleaners.

Dewey and Almy development engineers have made an exhaustive study into the problems of gasketing these products. The results, which are available to you for the asking, indicate that DAREX "Flowed-in" gaskets cut deeply into the cost of hand assembly.

## Here's why the "Flowed-in" process cuts costs

The amazingly-simple "Flowed-in" process eliminates the excessive time, motions and money required in hand assembly of gaskets to the lids of oil filters and air cleaners. In the "Flowed-in" process, the lids are revolved automatically while a uniform circular track of liquid gasket material is deposited where needed. Baking or drying transforms the fluid into a rubbery gasket that adheres to the lid. You save — in labor, by eliminating hand assembly — in materials, by eliminating waste and improving quality.

**THE "FLOWED-IN" WAY.** *With a* DAREX *semi-automatic machine, there are only two hand motions. Operator feeds with one hand, clears with the other.*



Dewey and Almy provides everything you need to take advantage of these savings: tested gasketing compounds, application equipment, more than 30 years of research and engineering experience. Let us show you specifically what your savings will be from the DAREX "Flowed-in" gasket process! Phone, wire or mail the coupon *today!*

**Discover what DAREX "Flowed-in" GASKETS can do for you!**

MAIL THE COUPON TODAY!

**DEWEY AND ALMY CHEMICAL COMPANY**
**Division of W. R. Grace & Co.**
**Cambridge 40, Mass.**

Please send me the new DAREX Flowed-in GASKET Brochure.

Name _____

Firm _____

Street _____

City _____ State _____

**DEWEY and ALMY**
**Chemical Company**
DIVISION OF W. R. GRACE & CO.
**Cambridge 40, Massachusetts**


SAE JOURNAL, April, 1955, Vol. 63, No. 4. Published monthly by the Society of Automotive Engineers, Inc. Publication office, at 10 McGovern Ave., Lancaster, Pa. Editorial and advertising department at the headquarters of the Society, 29 West 39th Street, New York 18, N. Y. $1 per number; $10 per year; foreign $12 per year; to members 50 cents per number, $5 per year. Entered as second class matter, September 15, 1948, at the Post Office at Lancaster, Pa., under the act of August 24, 1912. Acceptance for mailing at special rate of postage provided for in the Act of February 28, 1925, embodied in paragraph (d-2), Sec. 34.40, P. L. and R., of 1948. Additional entry at New York, N. Y.

# Precision "O" Rings and Dyna-seals are solving new design problems every day!

**Precision "O" Rings**
—carefully inspected, high quality, tough, compression molded!

**Precision Dyna-seals**
—for sealing under bolt heads, rivets, flanges, circular flat surfaces—no groove necessary.

**THEY LICK LEAKAGE!**

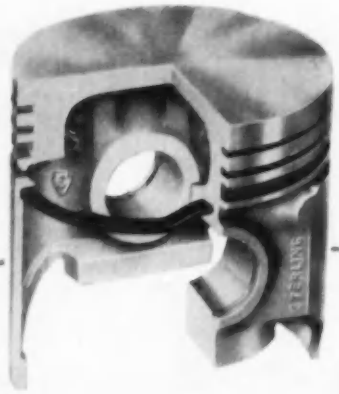
"THIS CASE IS SEALED" with 12 Precision Dyna-seals
14 "Floating" Precision "O" Rings
Precision Dyna-seals solve plug sealing problems on
NATCO
Precision Dyna-seal plays vital role in leak-proof operation of this Hydraulic Relief Valve
Dyna-seal
Swing to PRECISION "O" RINGS for economy and rugged service!
Precision "O" Rings for aircraft
Precision "O" Rings assure proper cushioning, perfect performance, positive sealing for CARTRIDGE UNITS

Shown here are just a few among the hundreds of today's successful designs that employ *PRECISION "O" Rings* and *Dyna-seals* for simplicity, economy and leak-free service. Let *Precision* engineers help with your design. Write for free Handbook of valuable "O" Ring and Dyna-seal data!

## Precision Rubber Products CORPORATION

*"O" Ring and Dyna-seal Specialists*

**3110 Oakridge Drive, Dayton 7, Ohio** Canadian Plant at: Ste. Thérèse de Blainville, Québec



1953 **STERLING** introduced a new, amazing piston

1954 **ONE** car manufacturer selected the new piston

1955 **7** Manufacturers specify **STERLING**

# CONFORMATIC* PISTONS

**In 1956** . . . there will be more! This quick acceptance by automotive engineers is a result of the demonstrable superiority of Sterling Conformatic Pistons. Sterling Engineers will be glad to show you how Conformatic Pistons can improve your engine's performance. Conformatic eliminates cold slap, scuffing and frictional power losses . . . because it conforms exactly to the cylinder walls over the entire operating range. Your Sterling Engineer can give you complete details and arrange a test.

*Now* **LOW-COST**

## RING LAND PROTECTION

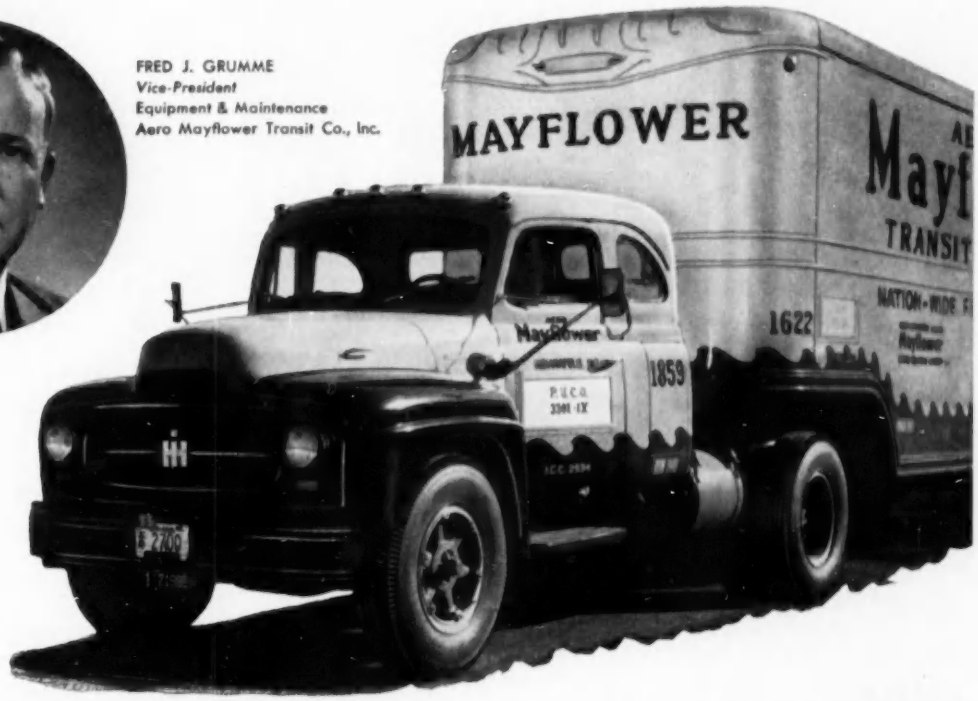
***in Sterling* CONFORMATIC *Pistons***

Ring grooves lined with lightweight intra-cast steel inserts give Sterling Conformatic Pistons even longer life . . . greater efficiency. An optional feature for truck and passenger car pistons.

**STERLING ALUMINUM PRODUCTS INC.**
ST. LOUIS, MISSOURI

*TRADE NAME REGISTERED

FRED J. GRUMME
*Vice-President*
Equipment & Maintenance
Aero Mayflower Transit Co., Inc.




# HOW ROSS STEERING SAVES MAYFLOWER

## *Time . . . Worry . . . Money*

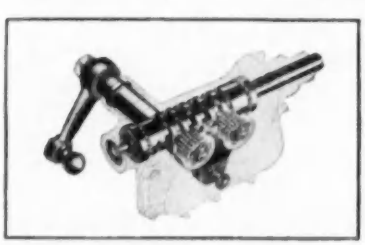
▶ **"All our Internationals** have Ross Steering," says Fred J. Grumme, Vice-President in charge of Equipment and Maintenance, Aero Mayflower Transit Co., Inc., nation-wide furniture movers.

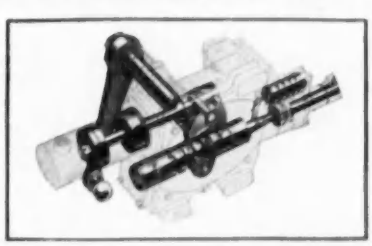
**Mr. Grumme** continues, "Our drivers like the ease, stability and safety that Ross Steering gives. And we like Ross' excellent record of trouble-free performance and long service life. All this adds up to faster, safer moves and minimum down time. In short, we figure that Ross Steering helps save Mayflower *time, worry* and *money*."

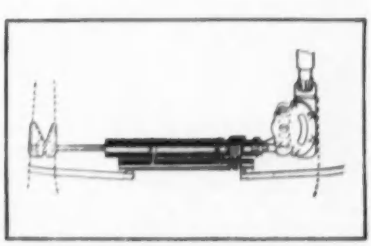
**Exclusive steering specialists** for 49 years, Ross provides the *right* gear for every steering need—manual or power—and invites discussion of *any* steering problem.

**ROSS GEAR AND TOOL COMPANY · LAFAYETTE, INDIANA**

Ross
STEERING







**CAM & LEVER MANUAL . . . HYDRAPOWER INTEGERAL . . . HYDRAPOWER LINKAGE**

# QUALITY

Your high grade machines deserve MECHANICS Roller Bearing UNIVERSAL JOINTS quality. You can benefit from the protection and convenience of "once-a-season" or "lifetime" lubricated MECHANICS roller bearing universal joints — and still have the economy of stamped yoke construction. Let our engineers show you how MECHANICS Roller Bearing UNIVERSAL JOINT developments will give your machines competitive advantages.

**MECHANICS UNIVERSAL JOINT DIVISION**
Borg-Warner • 2032 Harrison Ave., Rockford, Ill.

# MECHANICS
*Roller Bearing* BW
# UNIVERSAL JOINTS

For Cars • Trucks • Tractors • Farm Implements • Road Machinery • Aircraft • Tanks • Busses and Industrial Equipment

You carry me back to ol' Aunt Jinny—

*and so do*

# DAVENPORTS ON WHEELS!

**Aunt Jinny loved big, bulky furniture.** Her old-fashioned parlor was overstuffed with it. Too bad that the direct descendants of Aunt Jinny's sofa are *still* overstuffing many automobiles.

**There's no space for useless bulk** in today's ever-lower cars – and the most forward-looking designers are proving there's no *need* for it, either.

**Working with Airfoam Development Engineers,** they use AIRFOAM in ways that amaze old-time upholsterers. They are already reclaiming much needed space – and improving the ride as well!

**The newest Airfoam seat-units** are premolded *one-piece finished* cushions! They eliminate bulky assemblies and much costly upholstery work. They add style, glamour, long-trip comfort for driver and passengers – and *room,* precious *ROOM!*

**You and your people** can find much of great interest in what we are doing here at Goodyear. Let us tell you – and show you – more. Goodyear, Automotive Products Dept., Akron 16, Ohio.

Airfoam

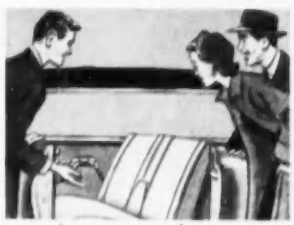
MADE ONLY BY GOODYEAR

THE WORLD'S FINEST MOST MODERN CUSHIONING

AIRFOAM *makes interiors roomier, more luxurious*

*Premolded* AIRFOAM *replaces expensive handwork – looks even richer*

*Exciting new seating ideas become practical with* AIRFOAM



AIRFOAM *can be your greatest sales-aid in years*

Airfoam – T. M. The Goodyear Tire & Rubber Company, Akron, Ohio

*We think you'll like "THE GREATEST STORY EVER TOLD" – every Sunday – ABC Radio Network – THE GOODYEAR TELEVISION PLAYHOUSE – every other Sunday – NBC TV Network*

# QUALITY

Your high grade machines deserve MECHANICS Roller Bearing UNIVERSAL JOINTS quality. You can benefit from the protection and convenience of "once-a-season" or "lifetime" lubricated MECHANICS roller bearing universal joints — and still have the economy of stamped yoke construction. Let our engineers show you how MECHANICS Roller Bearing UNIVERSAL JOINT developments will give your machines competitive advantages.

**MECHANICS UNIVERSAL JOINT DIVISION**
Borg-Warner • 2032 Harrison Ave., Rockford, Ill.

# MECHANICS
*Roller Bearing* BW
# UNIVERSAL JOINTS

For Cars • Trucks • Tractors • Farm Implements • Road Machinery • Aircraft • Tanks • Busses and Industrial Equipment

You carry me back to ol' Aunt Jinny—

*and so do*

# DAVENPORTS ON WHEELS!

**Aunt Jinny loved big, bulky furniture.** Her old-fashioned parlor was overstuffed with it. Too bad that the direct descendants of Aunt Jinny's sofa are *still* overstuffing many automobiles.

**There's no space for useless bulk** in today's ever-lower cars – and the most forward-looking designers are proving there's no *need* for it, either.

**Working with Airfoam Development Engineers,** they use AIRFOAM in ways that amaze old-time upholsterers. They are already reclaiming much needed space – and improving the ride as well!

**The newest Airfoam seat-units** are premolded *one-piece finished* cushions! They eliminate bulky assemblies and much costly upholstery work. They add style, glamour, long-trip comfort for driver and passengers – and *room,* precious *ROOM!*

**You and your people** can find much of great interest in what we are doing here at Goodyear. Let us tell you – and show you – more. Goodyear, Automotive Products Dept., Akron 16, Ohio.

Airfoam

MADE ONLY BY GOODYEAR

THE WORLD'S FINEST MOST MODERN CUSHIONING

AIRFOAM *makes interiors roomier, more luxurious*

*Premolded* AIRFOAM *replaces expensive handwork – looks even richer*

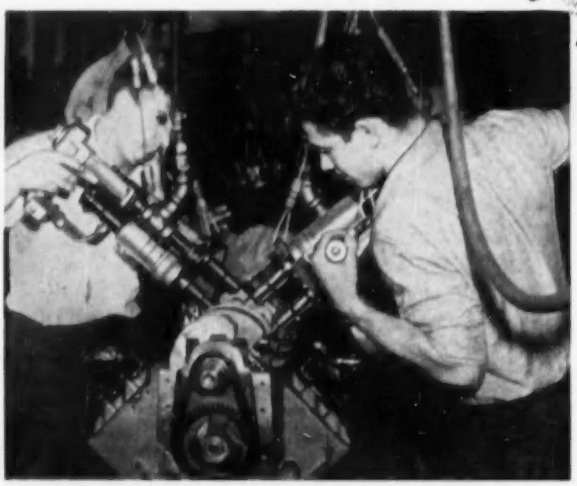
*Exciting new seating ideas become practical with* AIRFOAM

AIRFOAM *can be your greatest sales-aid in years*

Airfoam – T. M. The Goodyear Tire & Rubber Company, Akron, Ohio

*We think you'll like "THE GREATEST STORY EVER TOLD" – every Sunday – ABC Radio Network – THE GOODYEAR TELEVISION PLAYHOUSE – every other Sunday – NBC TV Network*

# Multiple Spindles provide Greater Output!



2-Spindle Multiples tighten connecting rod bolts on the assembly line.

A 6-spindle Multiple Nut Setter assembles automobile crankshaft to flywheel.

The new Keller Multiple Nut Setters improve quality control and reduce production costs. Manufacturers have been quick to make use of their advantages:

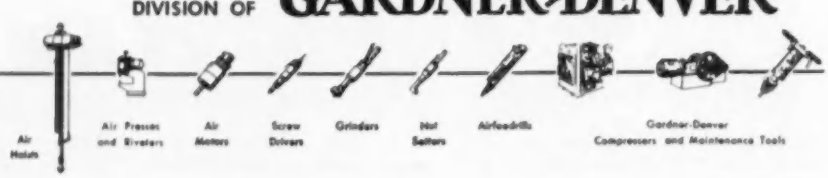
1. Built-in torque regulation in each individual spindle, giving control of torque on each bolt. Torque is adjustable from 4 to 190 ft/lb.
2. Torque held within close tolerances—comparable to that obtainable with accurate hand tools.
3. Increased production and lower production costs.
4. Easily adaptable to changing needs . . . a change in bolt spacing merely requires a new mounting plate for the spindles . . . when a job is completed the spindles are completely salvageable for use in another Multiple.

Do you have applications where bolts or nuts can be run and tightened two or more at a time? If so, it will pay you to investigate this remarkable tool. Write for Bulletin 16-101.

**KELLER TOOL**

DIVISION OF **GARDNER-DENVER**

GRAND HAVEN, MICHIGAN



## Auto-Lite is world famous for long life, performance and economy

Around the world, more than 400 products of Auto-Lite are used day and night in cars, trucks, planes, boats and industry . . . convincing proof of the outstanding quality made possible by Auto-Lite advanced engineering and precision manufacturing. So to get the best in long life, in power and performance and in economy, it pays to insist on world famous Auto-Lite products.

*Manufacturers of* BATTERIES • BUMPERS • FUEL PUMPS • HORNS • GENERATORS • LIGHTING UNITS SPEEDOMETERS • SPEEDOMETER CABLE • SWITCHES • STARTING MOTORS INSTRUMENTS & GAUGES • IGNITION UNITS • MOULDED PLASTICS WINDSHIELD WIPERS • WINDOW LIFTS • SEAT MOVING MECHANISMS • HUB CAPS WIRE & CABLE • SPARK PLUGS • METAL FABRICATED ASSEMBLIES • GRAY IRON CASTINGS • ZINC & ALUMINUM BASE DIE CASTINGS

THE ELECTRIC AUTO-LITE COMPANY • TOLEDO 1, OHIO

The Fageol *Pony Express* is a "midget sized" delivery truck specially designed for city or suburban multi-stop delivery of bulky, low-density cargo. Made by the Twin Coach Company, of Kent, Ohio, the 2,785-pound *Pony Express* features simplified controls, excellent maneuverability, "sit or stand" right- or left-hand drive, fully automatic transmission, and special "hold-stop" service brakes.

# "Pony Express" delivery trucks rely on Bundyweld for vital tubing parts

WHY BUNDYWELD IS BETTER TUBING

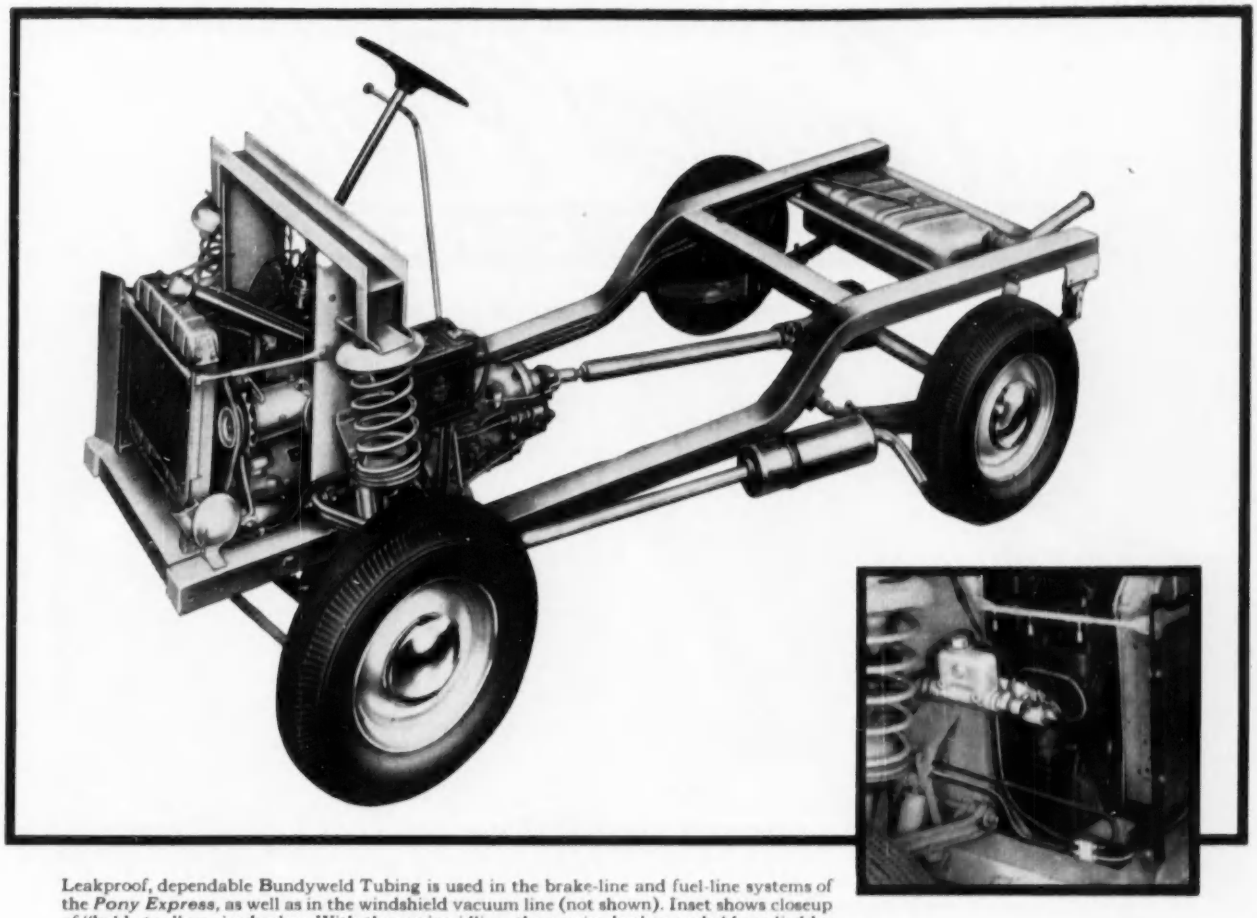
Bundyweld starts as a single strip of copper-coated steel. Then it's . . .

continuously rolled twice around laterally into a tube of uniform thickness, and

passed through a furnace. Copper coating fuses with steel. Result . . .

Bundyweld, double-walled and brazed through 360° of wall contact.

← **NOTE** the exclusive Bundy-developed beveled edges, which afford a smoother joint, absence of bead, and less chance for any leakage.



Leakproof, dependable Bundyweld Tubing is used in the brake-line and fuel-line systems of the *Pony Express*, as well as in the windshield vacuum line (not shown). Inset shows closeup of "hold-stop" service brakes. With the engine idling, the service brakes are held applied by a solenoid valve, even after the driver removes his foot from the brake pedal. Brakes are released when the accelerator pedal is depressed off idle position.

**The Twin Coach Company's** Fageol *Pony Express* has been specially designed to meet the need for a compact delivery truck which combines low-cost, dependable operation with maximum driver efficiency and comfort.

Naturally, the manufacturers of this sturdy, well-engineered, always-reliable delivery truck insist on a thoroughly dependable tubing for vital fuel, brake, and vacuum lines. *That's why their tubing choice centers on Bundyweld.*

**Here's why** you, too, can put your trust in this outstanding tubing: Bundyweld is leakproof by test; thinner walled yet stronger; can withstand heavy vibration fatigue, punishing wear; has high bursting strength. It's the only tubing double-walled from a single metal strip, copper-brazed throughout 360° of double-walled contact.

When you specify Bundyweld for your tubing needs, you not only get the industry's finest small-diameter tubing, but a host of valuable plus-services as well. You benefit from our technical assistance and engineering know-how; from our unexcelled facilities; and from our eager willingness to help you solve your tubing problem. Call, write or wire us.

**BUNDY TUBING COMPANY**
**DETROIT 14, MICHIGAN**

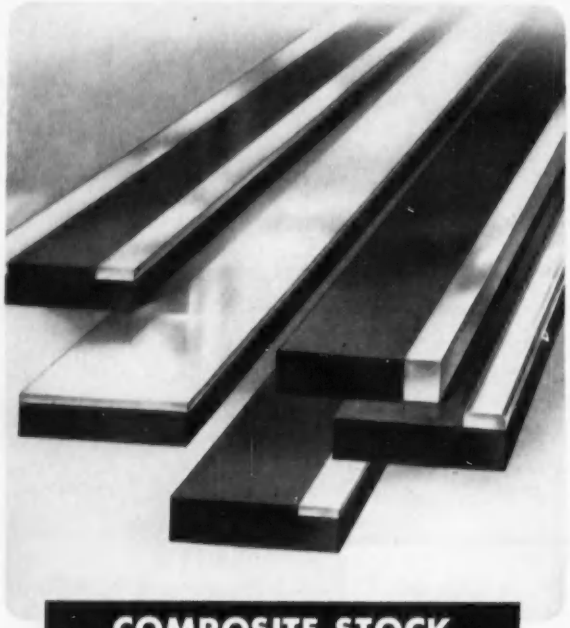
# BUNDYWELD TUBING®

**DOUBLE-WALLED FROM A SINGLE STRIP**

**Bundy Tubing Distributors and Representatives: *Cambridge 42, Mass.*:** Austin-Hastings Co., Inc., 226 Binney St. • ***Chattanooga 2, Tenn.*:** Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. • ***Chicago 32, Ill.*:** Lapham-Hickey Co., 3333 W. 47th Place • ***Elizabeth, New Jersey*:** A. B. Murray Co., Inc., Post Office Box 476 • ***Los Angeles 58, Calif.*:** Tubesales, 5400 Alcoa Ave. • ***Philadelphia 3, Penn.*:** Rutan & Co., 1717 Sansom St. • ***San Francisco 10, Calif.*:** Pacific Metals Co., Ltd., 3100 19th St. • ***Seattle 4, Wash.*:** Eagle Metals Co., 4755 First Ave., South ***Toronto 8, Ontario, Canada*:** Alloy Metal Sales., Ltd., 181 Fleet St., E. • **Bundyweld nickel and Monel tubing are sold by distributors of nickel and nickel alloys in principal cities.**

# General Plate

## COMPOSITE CONTACTS



COMPOSITE STOCK

FABRICATED ASSEMBLIES

## Composite Contact Material
### that meets your requirements
## Composite Contact Assemblies
### that cut your costs!

There are many advantages for using General Plate composite contact materials, processes and facilities. Among the more important are better performance, longer operating life and lower fabricating costs.

But that's not all — here at General Plate you have a single source that can supply your contact requirements be it composite raw stock, contacts or complete assemblies. General Plate stock and contacts are available in a wide range of alloys designed to meet your specific requirements.

General Plate Composite Contact Materials make it possible to manufacture complete contact assemblies to close tolerances by single blanking and forming operations. Compare this to other methods whereby the contacts and supporting members are fabricated separately and then assembled by brazing, welding or staking methods.

By letting General Plate fabricate your complete contact assemblies, you will save money, time and trouble . . . needless equipment cost and problems of scrap disposal are eliminated . . . contacts and/or contact assemblies made to your exact specifications are shipped to you ready for installation.

Write for complete information and Catalog PR700.

***You can profit by using General Plate Composite Metals!***

**METALS & CONTROLS CORPORATION**
**GENERAL PLATE DIVISION**
114 FOREST STREET, ATTLEBORO, MASS.

# For the Sake of Argument

## Driven by Dreams . . .

By Norman G. Shidle

"Organizations can suffer more from easily satisfied people than from inefficient or mediocre ones," an executive told us recently. Then he went on:

"That's because the inefficient eventually get written off—and the mediocre keep plugging along getting something done. Besides, both groups usually are in a minority.

"But most of us have a tendency to be too easily satisfied. It's only when we are stirred by unfulfilled dreams that we make our best contribution. A job well done is wont to fill us with a healthy satisfaction; to warm our spirits with a rejuvenating confidence . . . which is fine as far as it goes.

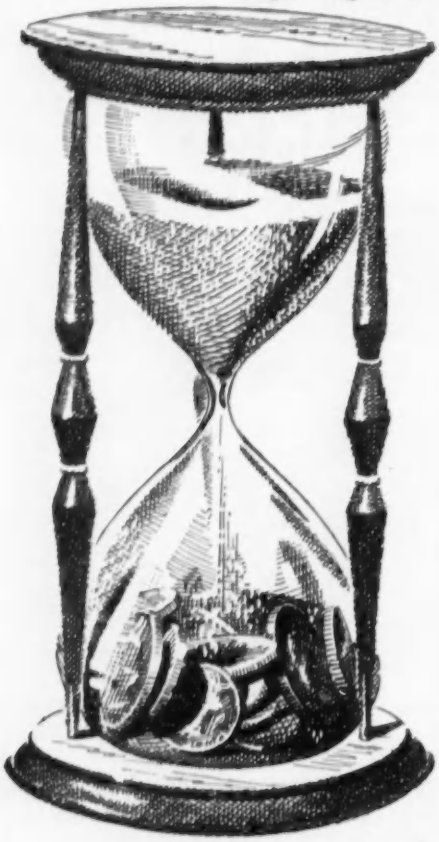
"But until we're disturbed by some new dream of a better way, our satisfaction can be inert. It's the everlasting launching of unfulfilled dreams that keeps us from getting tone-deaf to calls for action."

This executive agrees that it was an optimist—not a pessimist—who said that anticipation is better than realization. Recognition of that relationship points to life as good which is forever filled with anticipation.

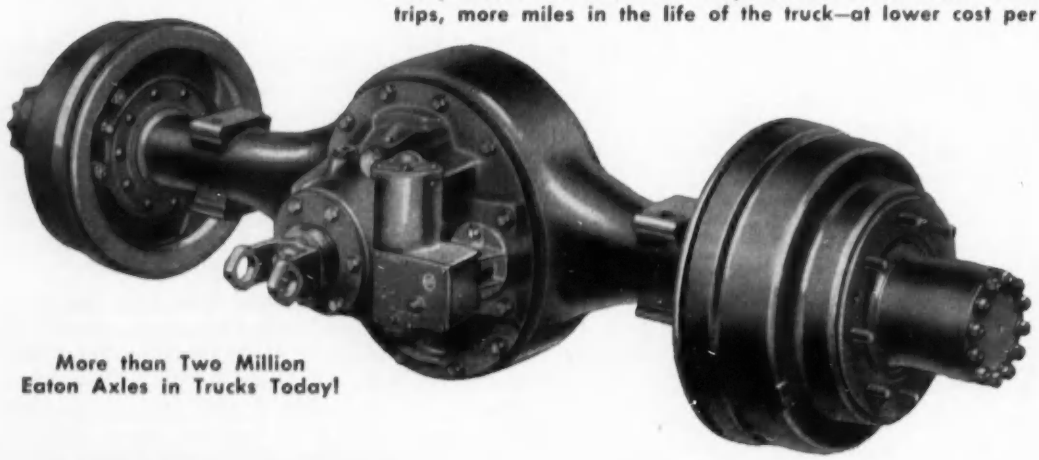
There is nothing like a little impatience with one's self to keep a life from running down. Self-criticism gone to seed, of course, can become a dead hand on the plow of progress. But a healthy impatience with where we are can help to breed the dreams we need to summon the best we have to give. Satisfaction with one's self is easy food on which to overeat.

"Blessed is the man," this executive remarked as he walked away. . . . "Blessed is the man who is driven by his dreams. He will never be satisfied to leave well-enough alone. . . . So, he will never face the barrenness of a safe future."

# Eaton 2-speed Axles Turn Time into Money for Truck Operators



**Eaton 2-Speed Axles may be the difference between profit and loss for those hauling jobs where time is a critical factor. They give trucks full pulling power for off-the-highway operation, plus the speed to make time on the open road. Because Eaton 2-Speeds reduce strain and wear on engines and power transmitting parts, and permit engines to run in their most efficient operating range, trucks are on the job—not in the shop. Eaton 2-Speeds give trucks greater maneuverability—an important factor in maintaining schedules in today's traffic. Eaton's exclusive features provide axles with greater stamina, hold maintenance to a minimum, assure maximum earning ability. Specifically: by supplying the right gear ratio for every road and load, Eaton 2-Speed Axles mean more and faster trips, more miles in the life of the truck—at lower cost per mile.**



**More than Two Million Eaton Axles in Trucks Today!**

**EATON** — AXLE DIVISION — MANUFACTURING COMPANY
CLEVELAND, OHIO

**PRODUCTS:** Sodium Cooled, Poppet, and Free Valves • Tappets • Hydraulic Valve Lifters • Valve Seat Inserts • Jet Engine Parts • Rotor Pumps • Motor Truck Axles • Permanent Mold Gray Iron Castings • Heater-Defroster Units • Snap Rings Springtites • Spring Washers • Cold Drawn Steel • Stampings • Leaf and Coil Springs • Dynamatic Drives, Brakes, Dynamometers

# SAE Journal

**Norman G. Shidle**
*Editor*

**Joseph Gilbert**
*Managing Editor*

**SAE JOURNAL PUBLICATION OFFICE**
Business Press, Inc.
10 McGovern Ave.
Lancaster, Pa.

**EDITORIAL OFFICE**
29 West 39 St.
New York 18, N. Y.
Tel.: LOngacre 5-7174

**ADVERTISING OFFICES**
E. D. Boyer
Eastern Advertising Manager
29 West 39 Street
New York 18, N. Y.
Tel.: LOngacre 5-7170

W. W. Milne
Western Advertising Manager
7530 Sheridan Road
Chicago 26, Illinois
Tel.: AMbassador 2-7091

A. J. Underwood
Midwestern Advertising Manager
3-210 General Motors Building
Detroit 2, Michigan
Tel.: TRinity 2-0606

**SAE DETROIT OFFICE**
R. C. Sackett, Staff Representative
808 New Center Bldg.
Tel.: TRinity 5-7495

**SAE WESTERN BRANCH OFFICE**
E. W. Rentz, Jr.
West Coast Manager
Petroleum Bldg.
714 West Olympic Blvd.
Los Angeles 15, Calif.
Tel.: Prospect 6559



The Society is not responsible for statements or opinions advanced in papers or discussions at its meetings or in articles in the Journal.



All technical articles appearing in SAE Journal are indexed by Engineering Index, Inc.



Copyrighted 1955 Society of Automotive Engineers, Inc.



Please address all editorial, advertising, and SAE Special Publications mail to:
29 West 39 Street
New York 18, N. Y.


1905 S.A.E. GOLDEN ANNIVERSARY 1955

## Contents—April, 1955


Air Pollution—G. P. LARSON, J. C. CHIPMAN, E. K. KAUPER, A. J. HAAGEN-SMIT, M. M. FOX, D. H. HUTCHISON, F. R. HOLDEN, W. L. FAITH, F. G. ROUNDS, P. A. BENNETT, G. J. NEBEL, J. T. WENTWORTH, and W. A. DANIEL ..... 17

Closer Cooperation—C. P. URBON ..... 20

Measuring Gear Wear by Geiger Counter—F. L. SCHWARTZ and R. H. EATON ..... 21

Kirksite Dies—G. W. PERIMAN ..... 24

Checklist for Designers . . . Keeping Aircraft Weight and Cost Down—E. H. HEINEMANN ..... 25

Airplane Speeds—SPENCER L. SHAW ..... 28

Fuel System Icing—J. F. MADDEN and E. A. DROEGEMUELLER ..... 29

Retrospection and Prophecy about Automobile Bodies—HARRY E. CHESEBROUGH ..... 30

Plastics for Tooling—A. A. MERRY, G. T. HUXFORD, and J. B. McCARRY 37

High-Speed Flight Has Its Own Special Problems—EARLE S. HODDER ..... 39

Analog Helps Solve Suspension Problems—DR. HORACE GROVER ..... 45

Wire Screw Inserts Get Military Standards—D. H. SECORD ..... 47

Research Group Aims for Answers On Truck-Highway Relationships—HOY STEVENS ..... 49

All-Metal Honeycomb Sandwich Structures—J. V. LONG and G. D. CREMER 53

TCA Views the Turbine Era—G. R. McGREGOR and J. T. DYMENT ..... 56

Thin High-Speed Props Must Withstand High Stresses—F. B. STULEN ..... 59

Where Should You Park 'Em?—R. W. THOMAS, J. M. McGINNIS, and R. M. KNUTSEN ..... 63

Diesels Wear Less with Oils of Increased High-Temperature Viscosity, Decreased Volatility, Maximum Thermal Stability—H. V. NUTT, E. W. LANDEN, and J. A. EDGAR ..... 64

Report of 1955 SAE Golden Anniversary National Passenger Car, Body, and Materials Meeting ..... 68

Report of 1955 SAE Automotive Ordnance Day ..... 73


■


SAE Section Meetings Schedule ..... 77

About SAE Members ..... 78

SAE Section News ..... 83

News of SAE ..... 92

SAE National Meetings Schedule ..... 93

Technical Committee Progress ..... 94

Technical Digests ..... 95

New Members Qualified ..... 126

Applications Received ..... 132



**Society of Automotive Engineers, Inc.**

**C. G. A. Rosen**
President

**John A. C. Warner**
Secretary and Gen. Manager

**B. B. Bachman**
Treasurer

# Bendix Products Division

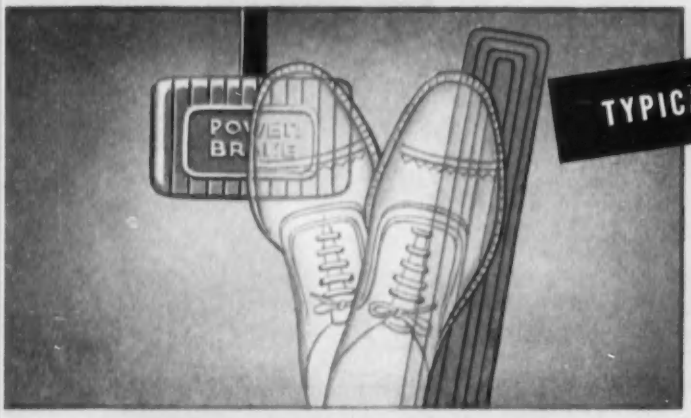
# A good reliable source

FOR AUTOMOTIVE COMPONENTS

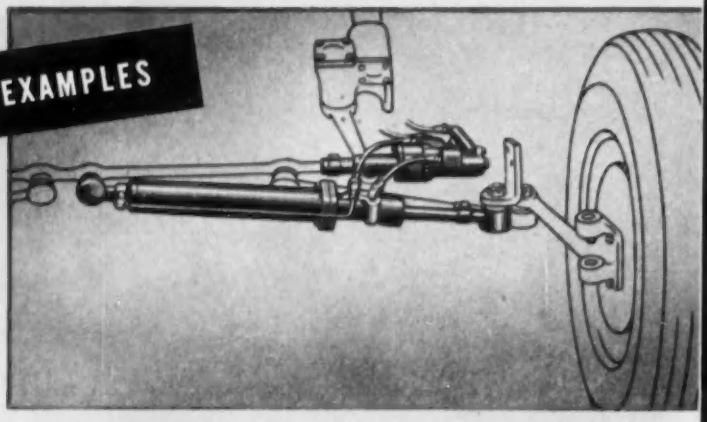
Because of long experience, serving many customers,

Bendix Products Division can apply much of the combined know-how of the automotive industry

to any specific project in the design and manufacture of automotive components.



TYPICAL EXAMPLES



**BENDIX LOW PEDAL POWER BRAKE**—Specified by more car manufacturers than any other make, Bendix* Low Pedal Power Brake makes possible quick, sure stops by merely pivoting the foot from the go to the stop control. No need to lift the foot and exert leg power to bring the car to a stop. Result—more driving comfort, less fatigue and greater safety!

**BENDIX LINKAGE TYPE POWER STEERING**—Because Bendix* Power Steering is of the linkage type, manufacturers find it especially adaptable for production line installation without extensive engineering changes. Manufacturers can now meet the ever-increasing demand for power steering more efficiently and more economically with Bendix Linkage Type Power Steering.

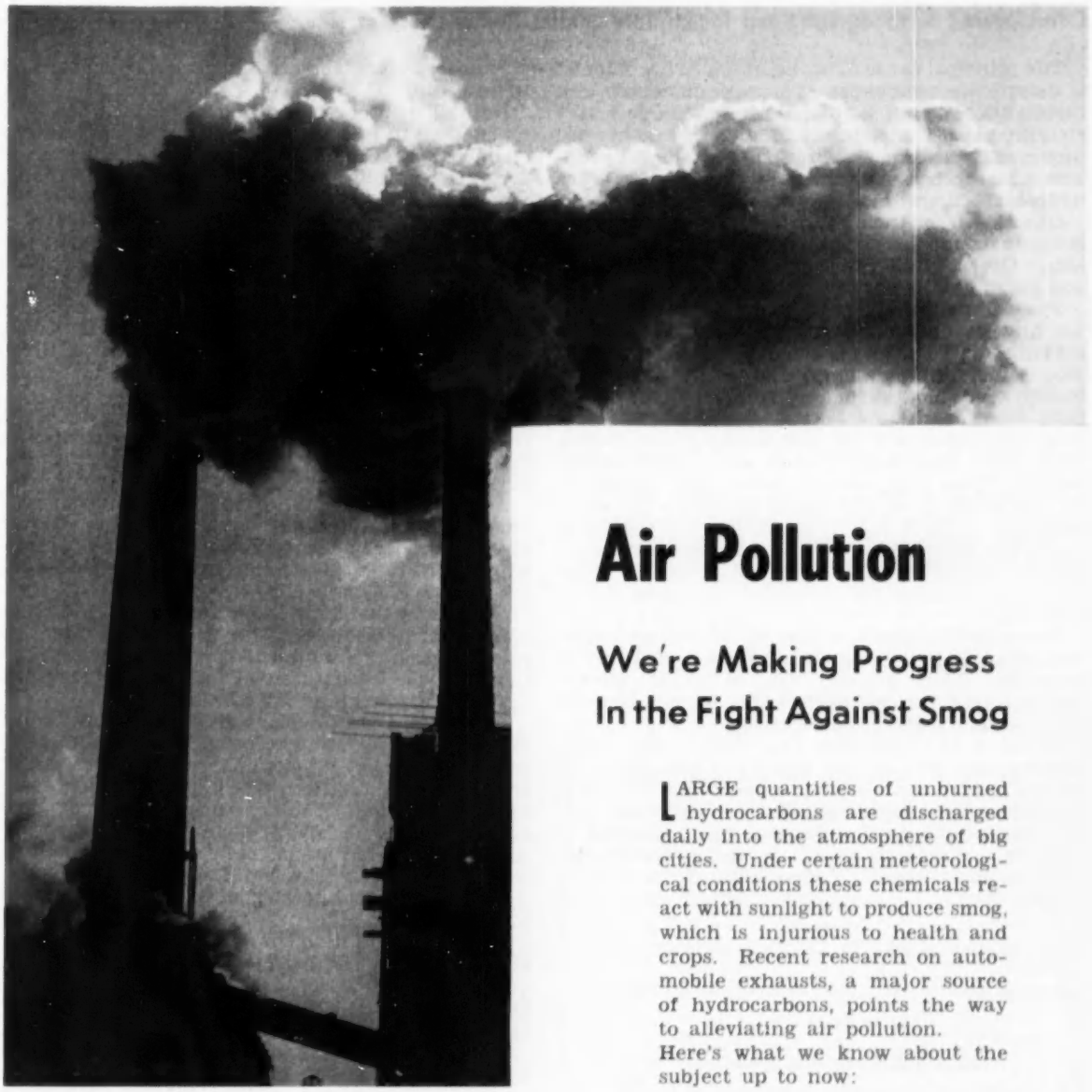
*REG. U.S. PAT. OFF.

**BRAKES • POWER STEERING • POWER BRAKING • CONSTANT VELOCITY UNIVERSAL JOINTS • HYDRAULIC REMOTE CONTROLS**

**BENDIX** PRODUCTS DIVISION **SOUTH BEND** INDIANA

Bendix AVIATION CORPORATION

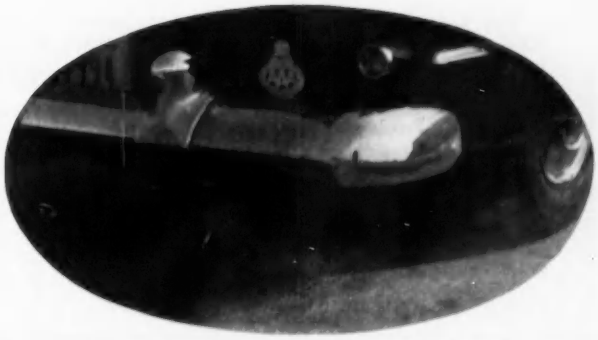
Export Sales: Bendix International Division, 205 East 42nd Street, New York 17, N. Y.



# Air Pollution

## We're Making Progress In the Fight Against Smog

LARGE quantities of unburned hydrocarbons are discharged daily into the atmosphere of big cities. Under certain meteorological conditions these chemicals react with sunlight to produce smog, which is injurious to health and crops. Recent research on automobile exhausts, a major source of hydrocarbons, points the way to alleviating air pollution.
Here's what we know about the subject up to now:



**Heavy industry and automobile exhausts are two of the sources that contaminate the atmosphere of our cities.**

## Combination of topography and incomplete combustion is cause of smog

The principal cause of air pollution in Los Angeles is incomplete combustion of organic materials and fuels. About 2600 tons of unburned organic materials are poured into the air each day. Another 440 tons comes from the evaporation of petroleum products. More than one third (over 1000 tons) are hydrocarbons emitted by automobile exhausts.

One reason for the large amount of exhaust gases is the extreme traffic density in the Los Angeles area. Over 2 million cars burn more than 4½ million gal of gasoline every day.

The polluted air does not blow away because of Los Angeles' unique topographical and meteorological situation. The city is bounded on three sides by mountains, forming a basin into which the onshore Pacific winds blow warm air. Trapped by the mountains from continuing Eastward, this warm (75 to 90 F) air becomes a lid over cooler air at ground level. This condition is known as temperature inversion. Thus, the cooler air cannot rise. Pollutants fill this lower level and are held captive for days, especially if there is little wind. Visibility is often cut to less than a mile. (In Los Angeles these conditions exist about 260 days per year. In other cities a temperature inversion happens infrequently.)

The mere presence of stagnant exhaust and combustion gases is not dangerous, or even particularly annoying. They are not what is called "smog." But materials that are in the exhaust gases produce smog under certain conditions.

Research has discovered that 88% of the hydrocarbons and 37% of the nitrogen oxide found in smog comes from automobile exhausts. When these compounds are exposed to sunlight in specific relative proportions, a photochemical reaction seems to take place, producing ozone, ozonized hydrocarbons, aerosols and peroxides. (Ozone is a dense form of oxygen, having a fresh, pungent odor.) It is these chemicals that attack crops, deteriorate rubber and irritate eyes.

Not all hydrocarbons produce ozone, however. As the length of the carbon chain in the straight chain paraffins increases from $C_4$ to $C_9$, the ozone forming capacity becomes greater. Methane, ethane, and propane are comparatively inactive.

Ozone formation depends upon the relative proportion of hydrocarbons and nitrogen oxides in the exhaust gases. This is determined by the different phases of automobile operation.

During idling, ozone is not formed unless additional $NO_2$ is available from some other source in the air. (This is the reason why, in the past, researchers have been unable to demonstrate ozone formation from exhaust gas.)

Mass spectrometer analyses have indicated that the hydrocarbon content of engine exhaust gas is fairly high (4%) when the fuel-air mixture is very rich, such as at idling.

At part-throttle, neither mixture ratio, compression ratio, fuel type, coolant temperature, engine type, engine speed or engine load has any appreciable effect on increasing hydrocarbon content from a low 1.5%.

But during deceleration—when manifold vacuum is above 21 in. of mercury—hydrocarbon content in exhaust gas increases to 12.5%. This is because the flame in the combustion chamber does not burn completely throughout the mixture.

A simple physical explanation: the exhaust valve opens too quickly and sweeps the unburned fuel-air mixture out before it has a chance to burn. Another theory is that dilution by residual gas limits complete combustion. The possibility that incomplete combustion may be partly due to pressure or other unknown factors has not been entirely eliminated. It does seem likely, however, that incomplete burning is not due to too low a concentration of fuel and air.

Nevertheless, during stop-and-go driving, such as encountered in the heavy Los Angeles traffic, the combination of idling, deceleration, and acceleration, produces an exhaust with the necessary proportions of hydrocarbon and $NO_2$ to form ozone.

One way of reducing smog would be to inhibit the presence of these two chemicals in exhaust gases, or at least lower their relative concentration below that necessary to produce ozone.

### A Civic Problem

**Although particularly indigenous to Los Angeles, air pollution has become a civic problem in other communities, too, such as London, New York, and Pittsburgh.**

**The "Great London Smog of 1952" that caused 4000 deaths, and the tragic sulphur blanket that suffocated Donora, Pennsylvania in 1948, have indicated the ultimate dangers.**

**Recently President Eisenhower called upon Congress to consider means of investigating and combating air pollution. Not waiting for Federal supervision, the Air Pollution Foundation, and other groups, have already contributed some information about the causes and effects of air pollution.**

## Solution is not easy; more facts needed

Preventing the discharge of hydrocarbons or $NO_2$ in exhaust gases—and thereby reducing smog—is not easy. Engineers have been attempting to do it for years. But new information indicates that through proper maintenance and design this can be accomplished.

The new V-8 engines should help reduce hydrocarbon emission since these engines will idle with leaner mixtures than either 6 cylinder or in-line 8 engines.

The trend toward automatic transmission and lower rear axle ratios tends to reduce hydrocarbon losses by reducing engine speed at a given car speed,

which reduces manifold vacuum during deceleration.

Advancing the spark will provide a longer burning time, although there are many problems connected with this solution.

By modifying the carburetor it is possible to reduce the amount and concentration of unburned hydrocarbons during deceleration. Two mechanical devices have been tested that (1) admits additional air and fuel to the intake manifold during deceleration, (2) shuts off the fuel during deceleration.

It is believed that devices can be built that will convert 60% of the unburned hydrocarbons in exhaust to inert gaseous products.

Eliminating all the unburned hydrocarbon emission during all driving conditions is exceedingly difficult. It is hoped eventually to be able to remove 90% from exhaust gases by an economical device or design.

Extremely conscious of the work to be done and dedicated to solve the problem is the Air Pollution Foundation. It is an independent non-profit corporation established for the following purposes:

1. To cooperate with, and to assist in coordinating the efforts of governmental agencies, educational institutions, specialized research groups, and medical, legal, and other technologists, so that every phase of air pollution shall be the object of careful study and constructive, remedial action.

2. To provide for the conduct of research on those phases of the problem not already undertaken or completed by other agencies.

3. To inform the public periodically concerning the nature and extent of air pollution, progress made in its elimination, and obstacles to such elimination.

Several research projects have already been instigated by APF whose first goal is to get further facts such as those discussed in this article.

Both the automotive and petroleum industries have shown evidence of civic responsibility by joining the movement and starting actual research work on reducing the hydrocarbon content of automobile exhaust gases.

## Based on discussion . . .

**J. M. Chandler,**
Ford Motor Co.

Ford has been very active in the field of exhaust gas and air pollution. We are using both the mass spectrometer and chemical combustion methods for determining exhaust gas composition. There is great need for a simple, rugged, accurate and preferably continuous analysing instrument that will identify all exhaust gas components and enable the engineer to determine the effect of engine operation changes on exhaust gas composition.

We have reduced hydrocarbon emission during deceleration by eliminating fuel flow during most of the deceleration cycle. This, however, causes several small complications to arise. Improving

## Air Pollution Symposium

**This article is based on papers presented at the Air Pollution Symposium, during the SAE Golden Anniversary Annual Meeting, Detroit, January 10, 1955. Symposium was sponsored by the Diesel Engine, Fuels and Lubricants, Passenger Car, Transportation and Maintenance, and Truck and Bus Activities.**

Chairman

**J. M. Campbell,**
Research Laboratories, Div., General Motors Corp.

Secretary

**C. M. Heinen,**
Chrysler Corp.

**These papers are available in full in multilithographed form from SAE Special Publications, 29 W. 39th Street, New York 18, New York. Price (each): 35¢ to members; 60¢ to nonmembers:**

**A Study of the Distribution and Effects of Automotive Gases in Los Angeles**

**G. P. Larson, J. C. Chipman and E. K. Kauper,**
Air Pollution Control District, Los Angeles County

**Automobile Exhaust and Ozone Formation**

**A. J. Haagen-Smit,**
California Institute of Technology, and

**Margaret M. Fox,**
Air Pollution Control District, Los Angeles County

**An Inventory of Automobile Exhaust Gases**

**D. H. Hutchison and F. R. Holden,**
Stanford Research Institute

**SCAPF—What It Is and What It Does**

**W. L. Faith,**
Air Pollution Foundation

**Some Effects of Engine-Fuel Variables on Exhaust Gas Hydrocarbon Concentration**

**F. G. Rounds, P. A. Bennett, and G. J. Nebel,**
Research Laboratories Div., General Motors Corp.

**Flame Photographs of Light Load Combustion Point the Way to Reduction of Hydrocarbons in Exhaust Gas**

**J. T. Wentworth and W. A. Daniel,**
Research Laboratories Div., General Motors Corp.

combustion efficiency during the other cycles of engine operation is going to be difficult.

An increase in fuel volatility seems to offer no improvement in combustion efficiency.

**F. C. Mock,**
Bendix Aviation Corp.

Perhaps the major actual cause of hydrocarbon emission comes from having fuel in liquid state in the intake manifold at full open throttle. This liquid fuel "flashes" into fog or vapor when the throttle is closed, giving temporarily a very rich mixture to the cylinders. Rich mixture, of course, increases hydrocarbon content of exhaust gases.

One cure would be to educate the motorist to keep his engine, valves, and ignition in shape to fire steadily without missing, on a carburetor idle adjustment that would give lean mixtures. Further improvement would result from the use of a "de-gasser."

For large gasoline trucks and bus engines the alternatives are:

(a) smaller manifolds, more manifold heat, and less acceleration charge. A "de-gasser" or fuel cut-off on deceleration would also be necessary,

(b) a vacuum operated auxiliary air port in the intake manifold,

(c) a different form of fuel injection with a deceleration fuel cut-off.

# Closer Cooperation . . .

## . . . between design engineer and manufacturing engineer pays off in better, cheaper products.

COMPANIES like Sperry Gyroscope and Westinghouse are acquainting draftsmen more thoroughly with the capabilities and limitations of production machines and forming and fabrication processes. They are also bringing the manufacturing engineer to the drafting board to check the producibility of the design while it is in its early stages.

The better the communication of ideas between drafting room and shop, the easier it is for each group to do its work. For example, the Ladish Company urges its customers to specify on their drawings for forgings what tolerances they can stand on size, contour, and surface deviations.

Knowing this, the forge shop can choose the most economical dies that will do the job satisfactorily. There's no sense in using costly machined dies if cast dies are accurate enough.

By specifying permissible dress-outs and match shifts, customers save themselves the cost of forgings that might otherwise be needlessly scrapped. Dressing out removes the blemishes that result from billet defects so small they escape magnetic-particle, black-light, and sonic inspection. Dressing out can also remove wrinkles caused by misalignment of dies and consequent shifting of forgings.

But dressing out a minor wrinkle sometimes brings the part outside dimensional tolerances. Customers should decide whether to put up with the wrinkle—or pay for the discarding of a forging. The decision should be indicated on the drawing.

Manufacturing experts are conveying to designers the news that there are many new processes at their disposal. For example, Thompson Products has made long strides in precision forging, contour machining, cold turning, flow turning and shear forming. The company is even rolling contoured airfoil strips. These are later cut into blade lengths, then heat-treated and twisted.

**SERVING on the panel on Improved Manufacturing Methods which developed the information on this page were**

**K. W. Stalker,** General Electric Co., panel leader

**C. P. Urbon,** General Electric Co., panel secretary

**J. S. Burdett,** Westinghouse Electric Corp.

**H. P. McDermott,** Sperry Gyroscope Co.

**A. A. Merry,** Pratt and Whitney Aircraft Division

**G. W. Periman,** North American Aviation, Inc.

**Karl Scheucher,** Thompson Products, Inc.

**T. L. Swansen,** Ladish Co.

**The panel was held as part of the SAE Aeronautic Production Forum, New York, April 12, 1954. A report on this panel is available in multilithographed form together with reports of the six other panel sessions of the 1954 SAE Aeronautic Production Forum. This publication, SP-307, is obtainable from the SAE Special Publications Department. Price: $1.50 to members; $4.00 to nonmembers.**

# Measuring Gear Wear By Geiger Counter

**F. L. Schwartz and R. H. Eaton,**

Engineering Research Institute, University of Michigan

Based on paper "Wear Rates of Gears By The Radioactive Method" presented at the SAE National Tractor Meeting, Milwaukee, September 15, 1954.

A NEW method of determining the rate of gear wear has been devised. The gear is made radioactive by exposing it to radiation from a nuclear reactor. Then, as particles of metal are worn off during use, they are circulated in oil past a geiger counter. The intensity of radiation is proportional to the amount of wear. By this method gear wear can be measured with various loads, speeds, and lubricants.

Older methods of determining wear consisted of operating a gear under various loads and speeds, then observing and measuring the surface of the gear. But this gave little information about the *rate* of gear wear. And, only those critical loads or speeds at which accelerated or destructive wear began could be observed.

This radioactive method can measure very minute amounts of wear—as low as 50 micrograms per minute—at loads and speeds much below critical destructive conditions. Also, the amount of metal transferred from a pinion to a mating gear can be detected.

## Careful Calibration Is Necessary

Determining gear wear rates requires setting up and calibrating a test procedure. First, the gear to be tested is exposed to radiation in a nuclear pile. This changes some elements in the gear metal to radioactive iron isotopes. At the same time, iron powder, previously ground off the side of the gear, is inserted in the reactor so that it receives the same amount of exposure.

Some of this activated iron powder is then mixed

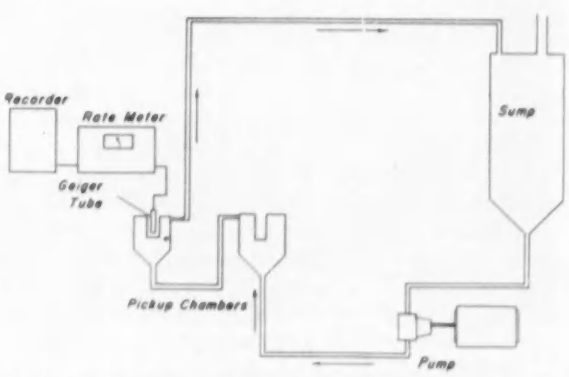



Fig. 1—Radioactive iron filings are circulated in this calibration system before testing for gear wear

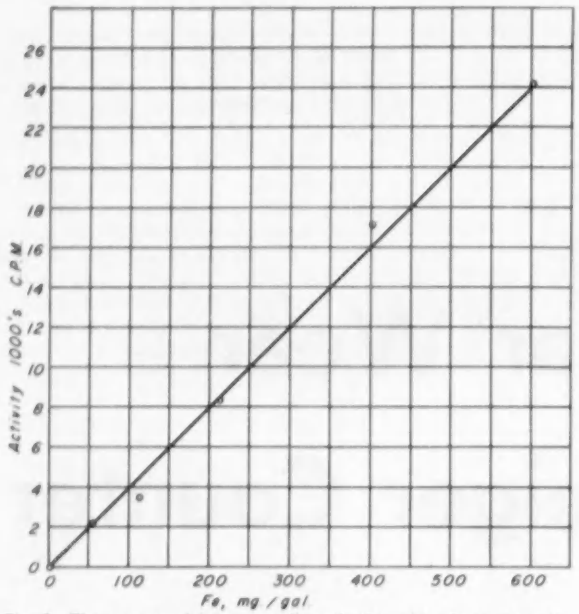



Fig. 2—The amount of iron per gallon of oil is plotted against radioactivity intensity for calibration purposes

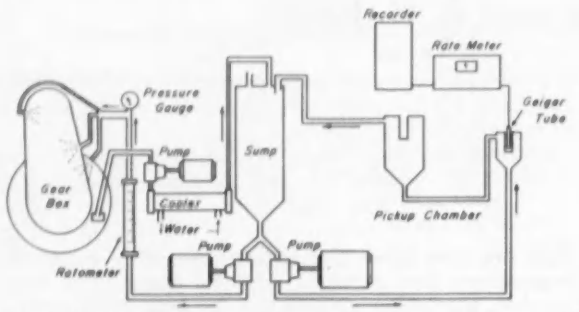



Fig. 3—A schematic diagram of the testing system. A four square testing arrangement provided torque as needed

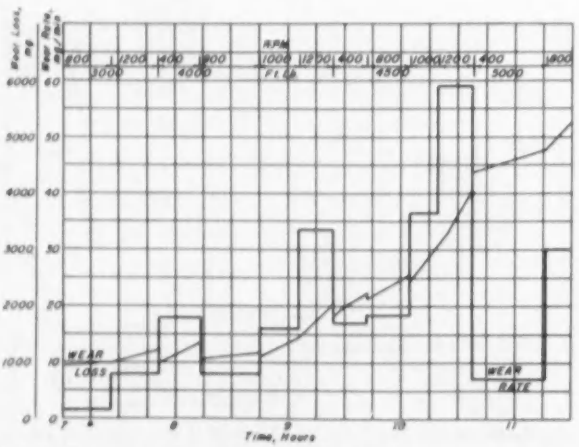



Fig. 4—This graph shows wear loss and wear rate for a test run using SAE 30 mineral oil

with a known quantity of oil circulated in a closed hydraulic system as shown in Fig. 1. A geiger tube detector measures the amount of radiation which is proportional to the amount of iron in the oil.

With the oil still circulating a small amount of activated iron and another gallon of oil is added. Then a reading is taken of the system's radioactivity. By successively adding more iron and oil, a calibration curve (Fig. 2) can be plotted. With this graph any activity reading can be converted to milligrams of metal per gallon of oil. (The curve must be corrected to take into account radiation decay.) Now we are ready for the actual wear rate test.

## A Typical Test Procedure

At the Engineering Research Institute, where this method was developed, the following test was run.

A testing system was set up as in Fig. 3. A radioactive sun gear was installed in the gear case. The oil system was filled with four gallons of SAE 30 mineral oil. After a four hour break-in run the gears were operated as follows:

| LOAD | SPEED |
|---|---|
| 3000 FT-LB | 400 RPM |
| 3000 | 800 |
| 3000 | 1000 |
| 3000 | 1200 |
| 4000 | 400 |
| 4000 | 800 |
| 4000 | 1000 |
| 4000 | 1200 |
| 4500 | 400 |
| 4500 | 800 |
| 4500 | 1000 |
| 4500 | 1200 |
| 5000 | 400 |
| 5000 | 800 |
| 5000 | 1000 |
| 5000 | 1200 |

As particles of iron wore off and circulated, a detector-rate meter-recorder unit registered the concentration of radioactive iron in the oil. By plotting a continuous graph of concentration versus time, as in Fig. 4, the rate of wear was found.

At the end of 10.83 hours the sun gear was badly

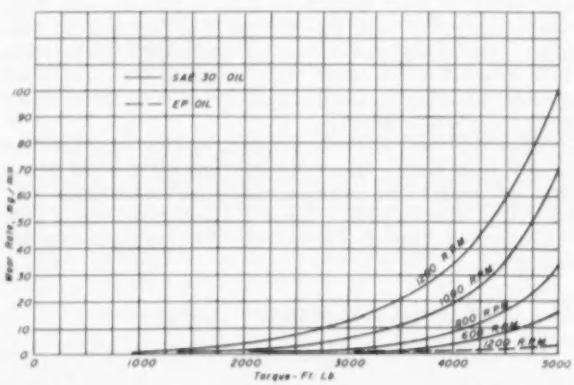



Fig. 5—At constant speeds wear rate increases exponentially with torque

worn. The wear rate continued to increase until 99 mg of metal were being worn off per minute at a speed of 1200 rpm and a load of 5000-ft-lb.

A second run was made after reversing the gears using an extreme pressure type of lubricant instead of the mineral oil. The wear rate was considerably reduced.

The effect of two kinds of oil on wear rate is clearly shown in Figs. 5 and 6. Increasing torque at constant speed or increasing speed at constant torque increases the wear rate exponentially. With wear rates vs load and speed available it becomes an easy matter to predict the life of a gear at any load and speed.

After the wear runs, the gears were exposed with photographic film to determine how much metal was transferred to the planet gears from the radio-

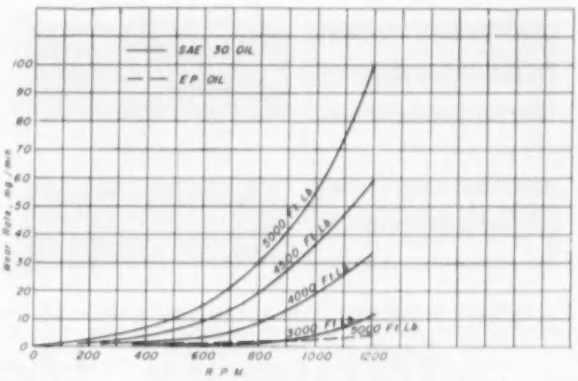
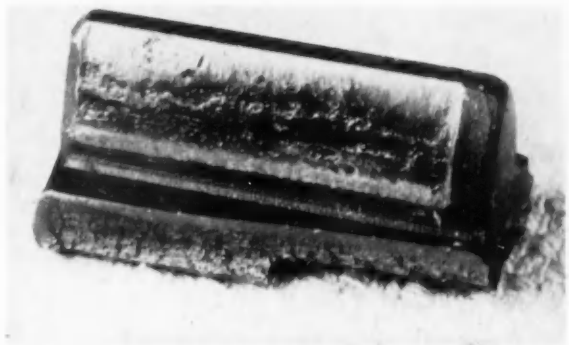
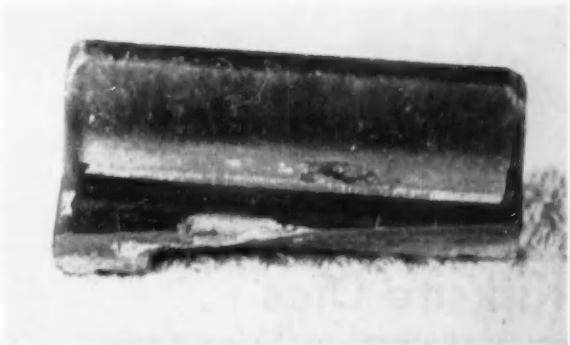



Fig. 6—At constant torques wear rate increases exponentially with speed

## Gears Wear Less With EP Lubricating Oil

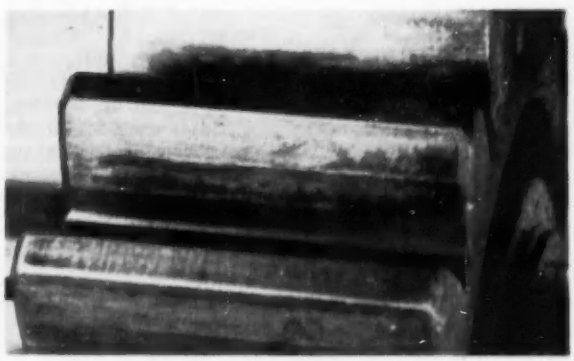


Sun gear after running 10 hr with SAE 30 oil



Sun gear after running 20 hr with extra pressure oil

Planet gear after running 10 hr with SAE 30 oil



Planet gear after running 20 hr with extra pressure oil

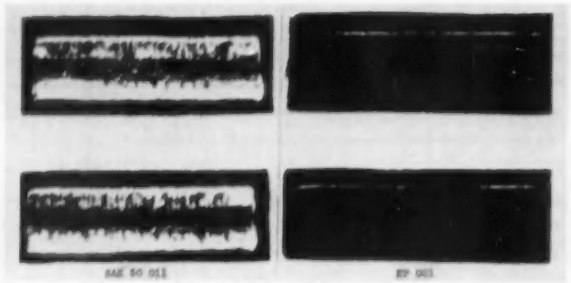


Fig. 7—The bright high-spots on the gear teeth radiographs at left are radioactive metal particles. Less metal is transferred from pinion to mating gear when using EP oil

active sun gear. The radiographs shown in Fig. 7 indicate a great amount of metal transfer when using a straight mineral oil. Comparatively little transfer when using an extreme-pressure oil.

### Based on Discussion

**I. E. Coleman,**
International Harvester

Question. Has any technique been developed to determine the distribution of load across the gear tooth?

Answer. Not yet, and there is room for further experiment along these lines. One indication would be the distribution of metal transferred.

**T. E. Gilbert,**
International Harvester

Question. Is there any limitation in size of gears that can be tested with this method?

Answer. The gear size is limited only by the amount of room in the reactor. At Oak Ridge, gears above 4½ in diameter could not fit in the reactor. The Phoenix Project reactor will be larger.

Question. What precautions are necessary to protect personnel from radiation?

Answer. It is not necessary at this level of activity for much shielding. During the experiment, the area was roped off. Standard safety equipment was used to check for radioactive contamination. Also, all personnel wore film badges and quartz-fiber electroscopes.

# Kirksite Dies . . .

## . . . for limited production of aluminum forgings are economical and perform satisfactorily.

Based on presentation by **G. W. Periman,** North American Aviation, Inc.

NORTH American Aviation forges small runs of 75S and 14S aluminum parts on dies cast of kirksite, the zinc-base white-metal alloy long used for forming dies. Parts forged range up to 8 × 10 × 48 in. Some of them have been thin-wing ribs with an overall dimension of 24 × 5 × 1½ in. with flange ½ in. thick. Webs less than ¼ in. in thickness are usually impractical to forge and maintain required tolerances in kirksite dies.

The largest piece forged to date is an L-shaped fitting with a U-shaped cross-section and overall dimensions of approximately 10 in. width × 24 × 24 in.

Forgings produced in kirksite dies do grow considerably. The first five to 10 pieces will grow 0.020 to 0.060 in. Growth on subsequent pieces must be watched carefully to see that parts don't exceed allowable limits. As many as 60 to 100 pieces have been run, experimentally, with tolerances maintained.

It saves time to forge parts instead of machining them from bar stock, even for the small runs for which kirksite is suitable. It takes only an average of 10 hr to cast kirksite dies. Cutting templates for kellering the production run takes much longer.

In casting kirksite dies, it isn't necessary to retain kirksite around the pattern, although a steel container will reduce the amount of die material needed.

Sheet kirksite can be used for blanking dies. On chromium-molybdenum steel, die life has run as high as 500 pieces on 0.035-in. thick stock and 200 pieces on 0.065-in. thick stock.

(This presentation was made at panel on Improved Manufacturing Methods held as part of the SAE Aeronautic Production Forum, New York, April 12, 1954.)

## Checklist for Designers . . .

# Keeping Aircraft Weight and Cost Down

**E. H. Heinemann,**
Chief Engineer, El Segundo Division, Douglas Aircraft Co., Inc.

Excerpts from paper "Design of Light-Weight, High-Performance Military Aircraft" presented at SAE National Aeronautic Meeting, Los Angeles, Oct. 8, 1954.

Excess weight is accompanied by inferior performance, disproportionately higher costs, and decreased reliability, says the recipient of the 1954 Collier Trophy for "the greatest achievements in aviation in America." Here's how he avoids it in his high-speed military aircraft designs:

### 1. Are the specification requirements reasonable?

While the aircraft designer may feel obliged to fulfill the requirements of a given specification, he has an even greater responsibility to be critical of these requirements and to suggest alterations wherever his experience indicates that the product will be improved thereby.

Perhaps the most practical and concrete way in which the airframe manufacturer can influence military planning is to make sure that all those concerned are well aware of the "weight growth factor" and the "cost growth factor." (See box on next page.) The economic consequences of unwarranted increases in airplane size must be fully understood and appreciated, not only by the designer of all the aircraft equipment, but also by the procuring organizations, particularly during the planning phase.

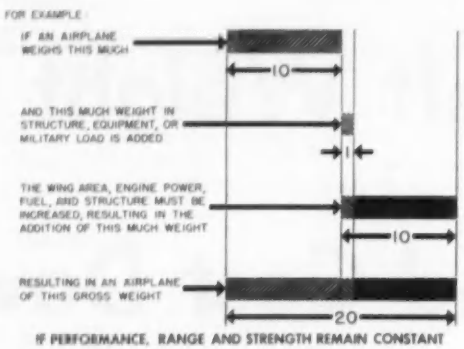
Another important subject that must be given full consideration in the planning stage is that of reliability and serviceability. The availability of an aircraft and consequently its tactical effectiveness are adversely affected by requirements that lead to increased complexity. So the military planners should make every effort to see that the need for a proposed item is not outweighed by the penalty it imposes on the reliability.

### 2. Is the design simple and reliable?

Fundamental simplicity results when everyone involved in the design has a clear understanding of the desired airplane and its mission and the entire machine—airframe, powerplant, controls, instruments, and weapons—is developed as a unit. Of course this is not always possible, because of the different development times of various components and the logistic requirement for interchangeability between different types of airplanes. Still, it is a

## Weight and Cost Growth Factors . . .

Weight and cost tend to snowball. When the designer adds a unit to the plane, he has to provide structure, power, and wing area to take care of it. As the chart shows, total weight increase may be 10 times as heavy as the unit added—that is, the weight growth factor may be 10, or even higher.


FOR EXAMPLE:
IF AN AIRPLANE WEIGHS THIS MUCH
10
AND THIS MUCH WEIGHT IN STRUCTURE, EQUIPMENT, OR MILITARY LOAD IS ADDED
1
THE WING AREA, ENGINE POWER, FUEL, AND STRUCTURE MUST BE INCREASED, RESULTING IN THE ADDITION OF THIS MUCH WEIGHT
10
RESULTING IN AN AIRPLANE OF THIS GROSS WEIGHT
20
IF PERFORMANCE, RANGE AND STRENGTH REMAIN CONSTANT

Weight costs money. While the factor that relates cost to weight varies somewhat for different components and from one manufacturer to another, it has been found in recent years that on the average a pound of weight costs $50 to develop and produce. When this factor is combined with a typical weight growth factor of 10, the cost of one pound of extra weight amounts to $500 per airplane if performance and strength are to be maintained.

The cost growth factor of $50 per pound is an average factor for a representative quantity of aircraft. In addition, for a fixed dollar expenditure, an increase in airplane size lengthens learning times for production workers and there again adds to costs.

most important matter, and every effort should be made to design all the components specifically for the one plane.

An example of what is meant by "fundamental simplicity" is the use of non-folding wings on a carrier-based airplane. In one case, very careful studies during the preliminary design showed that the size and weight could be reduced to a point where wing folding was no longer necessary. This in turn eliminated the normal increment of weight chargeable to wing folding and therefore resulted in a more efficient and simple airplane and one much easier to maintain.

Other examples of fundamental simplicity are frequently found in safety devices. There have been many instances where, in order to increase the reliability, secondary systems have been added, and it has turned out in the final analysis that the reliability of the basic system had been reduced by the secondary system. In many cases it has been found that for the same total amount of engineering effort expended, the primary system could have been developed to a much higher degree of safety.

Of course, simplification doesn't always save weight. There are some exceptions. In a number of specific instances, increased complexity has been specified intentionally in the interest of substantial weight saving. An example of this is the use of a yaw damper in place of added vertical-tail area. However, this method of reducing weight should be subjected to close scrutiny and employed only when the gains are very substantial.

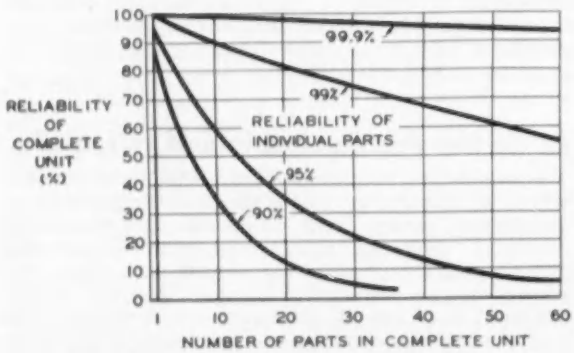



Fig. 1—Reliability is a function of the number of parts

The importance of reliability will be further emphasized by means of a numerical example. The overall reliability of any machine made up of a number of parts depends upon the reliability of the individual components. Fig. 1 illustrates the effect on the overall reliability of the number of individual parts as well as the effect of the reliability of each part. In the example shown, a number of items must all function properly to have the complete unit operate satisfactorily; in other words, there are no duplicate systems.

This may be illustrated by a case in which a fighter airplane is expected to make gunnery run on a target at high altitude. If the pilot is to have his chance to press the attack to successful completion, each of the following components must operate satisfactorily: The cockpit pressurization and air conditioning must operate properly for the pilot to exist in the high-altitude environment. The radar must operate properly to detect the attacking aircraft. The airplane control system and the fire control

system must function correctly. And, finally, the guns must fire satisfactorily.

The figure shows that if there are 10 such components in a system and if each is 99% reliable, the complete machine is 90% reliable. On the other hand, if each of 10 individual components is 90% reliable, the reliability of the complete machine is only 35%. It can be seen from this brief illustration that all of the designers and manufacturers involved in the final airplane and weapons systems must do their best to make the reliability of the individual components as high as possible. A reduction in the number of components, when possible, is of course a very effective means of achieving higher reliability.

## 3. Is the structure efficient?

In the primary weight breakdown for a typical jet-propelled combat airplane, the structure accounts for 30% of the weight.

Much has been done to decrease the structural weight, since this is controlled directly and completely by the airframe designer, the one who is most aware of the penalties of extra weight in a design. However, the benefits of increased structural efficiency have been offset by increased aerodynamic loading due to speed increases and the decreased structural thicknesses required to attain these speeds. And because of increased speeds, the air surrounding the structure has increased in temperature, resulting in a reduction in the allowable stresses. Thus there is still opportunity for improvements in these three categories:

*Architectural Arrangement*—In arranging the components of the airframe the broadest possible viewpoint should be held. The airplane will have the greatest efficiency and simplicity if the designer is willing to accept compromises in order to achieve an overall gain and to obtain the highest possible utility of all components.

A classical example of the latter is the use of the wing structure for integral fuel tanks—that is, using an existing structure for a secondary purpose. Such practices as combining tail-wheel and arresting-hook structure and utilizing structural strong points for attaching high-load-carrying members such as arresting hooks, catapult hooks, and landing gear are examples of other effective weight savers.

Another source of substantial structural gains has been the replacement of complicated, built-up structural sections by simpler machined parts.

*Materials*—Gains in structural efficiency have resulted through the use of improved materials having higher strength-to-weight ratios or better high-temperature characteristics. Foremost among these newer materials are 75 ST aluminum alloy, SAE 4340 steel heat-treated to 260,000 to 280,000 psi, and titanium. Further improvements are anticipated, but research to develop new materials should be vigorously pushed.

*Philosophy and Methods of Analysis*—Other important structural gains have come about as the result of improved methods of analysis that allow the design of structural members to closer margins. Equally important in this respect is the encouragement of all designers to design intentionally to minimum margins, even though this may involve some risk of re-design following static tests. Excessive conservatism in design can be avoided only if the entire design staff is imbued with this design philosophy.

## 4. Which powerplant is best?

Roughly 50% of the total airplane weight is assigned to the propulsion system and fuel. Usually the engine can not be made completely compatible with airframe requirements because only a limited number of engines of sufficiently advanced performance are available at any given time. The designer can aspire to approach the optimum airframe-engine combination, but will probably never quite realize this goal.

The problem of engine selection involves primarily the determination of the best balance between specific weight and specific fuel consumption. Whether improved fuel economy or low engine weight prevails depends largely on the airplane type and the airplane operational requirements. A long-range requirement or, more specifically, one that requires a large amount of fuel, usually favors engines having low specific fuel consumption, whereas a short-range requirement theoretically favors the lighter engines. It is perhaps significant that up to the present time, engines with the best fuel economy, even though somewhat heavier than their less economical competitors, have turned out better even for short-range airplanes.

Another question is whether to use an afterburning engine. At the present level of engine development and with the present operational requirements, this decision is not very difficult. Very high flight speeds automatically require afterburning engines. For almost all other applications the non-afterburning engine is superior.

For the same engine frontal area and roughly 10 to 20% more engine weight, the thrust at Mach 2 is increased by as much as three or four times by afterburning. On the other hand, for a given thrust the use of afterburning roughly doubles the fuel consumption.

As a consequence of the very poor fuel economy with afterburner operating, the attainment of supersonic flight speeds must be accompanied either by a reduction in other performance items such as range or combat time or by greatly increased airplane size. To keep airplane size within reasonable bounds, the solution adopted on current supersonic fighters has been the curtailment of combat time. Long periods of efficient supersonic flight will be attainable only with the development of superior non-afterburning engines having thrust-to-size ratios favorable enough for supersonic flight. The rapid progress made by engine manufacturers in recent years will have to be continued until this goal is met.

Another problem of general compatibility of the engine with airframe is the determination of the optimum number of engines. In general it appears that experience tends to favor the minimum number of engines, except where safety considerations

overshadow all others. Still another example of an airframe-engine compatibility problem is the matching of design speeds for engine and airframe. If a high-altitude interceptor employs an engine designed for very high sea-level speeds, it is probable that excess weight is being carried.

## 5. Can weight of equipment be cut?

A weight-saving campaign on equipment can be very profitable. Realizing this, some aircraft manufacturers have taken an active interest in equipment design. The reaction of the accessory manufacturers, during the last few years especially, has been most gratifying. In general, they have responded very well to the aircraft manufacturers' educational program and have in many cases redesigned their equipment not only to meet the airplane designers' requirements, but to better them considerably. Perhaps this is a natural situation, since most designers will agree that it takes two or three tries, or generations, in the development of any mechanical device to produce a really efficient one.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

# Airplane Speeds . . .

**. . . in foreseeable future can be handled with existing structural materials. However, new forms of propulsion might create severe materials problems.**

Based on paper by **Spencer L. Shaw,** Douglas Aircraft Co., Inc.

WHEN aircraft structure attains a temperature of about 200 F, which it will reach at a sustained speed of Mach 1.2 at sea level on a normal day, titanium alloys begin to become attractive as a replacement for aluminum alloys for the main structural material.

The upper limit of use of the presently available titanium alloys at sustained temperature is about 700 F. This limit is imposed, not by the reduction in static properties with temperature, but by the lowering of the creep properties. Because an airplane must be designed to avoid permanent deformation, a criterion covering creep must be adhered to, and at elevated temperatures this criterion becomes more difficult to meet than that for ultimate static strength. It is significant that the creep curve of C-110M alloy does not follow the yield strength curve. In the intermediate temperature range, stresses above the yield strength must be imposed upon the material in order to produce appreciable creep, whereas at near room temperature and at temperatures above approximately 700 F creep is observed at stresses below the yield strength of the material.

Above 700 F, stainless steel and cobalt-base alloys seem to be the most promising materials. Unfortunately the unstabilized 18:8 stainless steels begin to undergo a metallurgical change at about this temperature which makes them unsuitable for use at sustained temperatures. This leaves us with stabilized stainless and cobalt-base alloys. The upper limit for these materials will be about 1400 F due to the rapid decrease in creep properties at this temperature. This upper range takes us to about Mach 4 at sea level and Mach 10 at about 185,000-ft altitude. Sustained flight beyond these limits does not seem imminent.

The usable flight spectra of the various materials discussed are shown in Fig. 1. This figure shows the stabilized temperatures at speeds to Mach 10 and up to an altitude of 200,000 ft. The calculations assumed a recovery factor of 0.9, an emissivity factor of 1.0, and no solar heat. At the stagnation point near the nose of airfoil sections the temperature will be even somewhat hotter than shown, and special methods of construction might be necessary in this region. (Paper "Selection of Aircraft Construction Materials" was presented at SAE Los Angeles Aeronautic Meeting, Oct. 7, 1954. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members 60¢ to nonmembers.)

FLIGHT SPECTRA OF VARIOUS MATERIALS

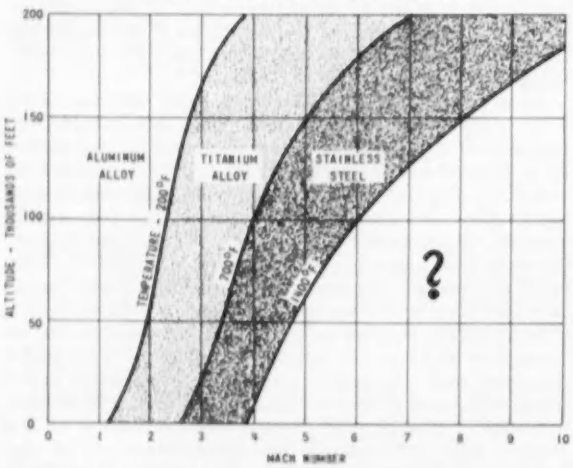



Fig. 1—In this chart of flight spectra of three aircraft structural materials the recovery factory is assumed to be 0.9, the emissivity factor 1.0, and there is assumed to be no solar heat

# Fuel System Icing . . .

## . . . can be prevented by forcing dry air over or through the fuel in the tank to remove dissolved water. JP-4 fuel dries faster than JP-5.

Based on paper by **J. F. Madden** and **E. A. Droegemueller,** Pratt & Whitney Aircraft

FUEL system malfunctioning due to the icing of the free water which finds its way into the fuel tanks can be overcome. At a fuel temperature of 40 F, forced ventilation of the tank with dry air can remove much of the dissolved water from fuel in a reasonable time provided a sufficient contact is obtained between the air and the fuel.

Results of investigation indicate that forced ventilation of the fuel tank cannot be expected to dry fuel below the water content associated with saturation at approximately – 10 F in a reasonable period of time. (Because of inaccuracies in the measurement of water content at the low values and uncertainties in the water solubility curves for the fuel, it is possible that in practice the temperature might differ somewhat from the -10 F value.)

The maximum rate of drying to be expected for a given airflow will occur when the fuel agitation and period of contact between the ventilating air and the fuel are such that equilibrium exists between the water in the fuel and the ventilating medium. The efficiency with which the ventilating air is used could be defined, therefore, as the ratio of the rate at which water was actually removed from the fuel compared to the rate at which it could be removed if equilibrium conditions prevailed. It was found that this efficiency varied throughout any one test in direct proporation to the water content of the fuel.

Reference to Table 1, Column 5 shows the initial efficiency to vary from a relatively small value in the cases where large quantities of air were merely passed over the surface of the fuel to considerably higher values in cases where the air was bubbled upward through the fuel from a manifold. The one efficiency greater than 100%—that is, 160%—is thought to be an anomaly due at least in part to the effect of the evolution of dissolved air from the fuel, but it may also be attributable to experimental error.

The drying time shown in Column 6 of Table 1 was arbitrarily selected as a figure of merit to facilitate a comparison of the various test conditions. It should be noted that the tests with the 40 F fuel were started at a water content approximately half of that prevailing at the start of those tests with the fuel temperature at 65-79 F. Therefore, a lower drying time for the colder fuel does not necessarily indicate a higher water removal rate. JP-4 fuel could be dried at a reasonable rate by flowing a large volume of air over the surface of agitated fuel or at an even faster rate by bubbling a relatively small volume of air through the fuel. JP-5 fuel dried more slowly than JP-4.

Additional testing would be required to determine whether or not satisfactory dehydration could be obtained if fuel were chilled to a temperature below the freezing point of water prior to attempted drying. (Paper "Tank Ventilation to Combat Fuel System Icing" was presented at SAE National Aeronautic Meeting, Los Angeles, Oct. 8, 1954. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

### Based on discussion

**A. B. Crampton,** Standard Oil Development Co.

Industry should not remove de-icing alcohol kits from present aircraft until such time as we know how to dispense with the extraneous or free water problem. For this ventilation technique to be most effective we must find some way to keep extraneous water out of the tanks and some method to avoid breathing moist air into the tanks during or following descent. Caution should be taken against bubbling large quantities of high temperature air through the fuel because of excessive vapor losses, especially at or above the boiling altitude. A distinct flammability hazard can result if hot compressor air is bubbled through fuel during high-speed flight. Both problems can be minimized by using low flows of cooler (cooler than 350-400 F) air.

Table 1—Summary of results of tests to remove water from fuel in tanks by passing dry air over the fuel with or without agitation and by bubbling air through the fuel.

**Table 1—Summary of Test Results**

| Ventilation Method | Airflow cfm | Type Fuel | Fuel Temp, F | Initial Efficiency, % | Time to Dry to 0.0015%, Minutes |
|---|---|---|---|---|---|
| Exposed inlet, No agitation | 196 | JP-4 | 69 | 1.4 | >180 |
| Exposed inlet, No agitation | 190 | JP-4 | 37 | 0.1 | >180 |
| Exposed inlet, Mild agitation | 190 | JP-4 | 65 | 5.0 | 55 |
| Exposed inlet, Severe agitation | 193 | JP-4 | 65 | 6.6 | 55 |
| Exposed inlet, Mild agitation | 210 | JP-5 | 79 | 0.5 | >180 |
| Submerged single point | 24.5 | JP-4 | 75 | 51 | 60 |
| Submerged manifold | 26.5 | JP-4 | 69 | 78 | 30 |
| Submerged manifold | 11 | JP-4 | 72 | 66 | 85 |
| Submerged manifold | 11.7 | JP-4 | 42 | 160 | 20 |
| Submerged manifold | 12.5 | JP-5 | 75 | 30 | 150 |
| Submerged manifold | 12.5 | JP-5 | 42 | 30 | 100 |

# Retrospection and Prophecy about

# Automobile

IT is natural at a time like this, the Golden Anniversary of the SAE and the Silver Anniversary of SAE Body Activity, to want to dwell on the past—to recount its great moments, relive its thrills, recite the accomplishments of its great men, and, of course, to predict the future. If the elements of the past which delineate our progress were at one time dreams of the future, so it is today. Before giving a brief but important resume of the past, let's take a forward look at some of the things that may become realities in the years ahead.

## I. FUTURE AUTOMOBILE TYPES: Three Will Predominate

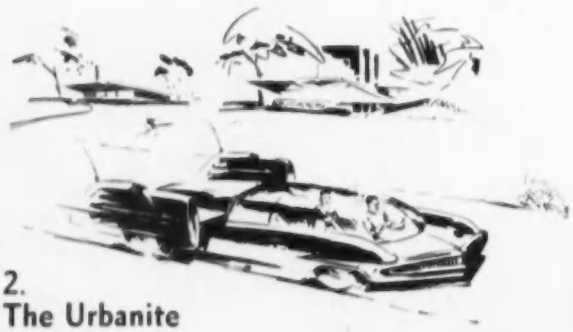
1.
The Highway
Cruiser

Automobiles will remain the basic medium of personal transportation, and may well evolve into three specialized types:

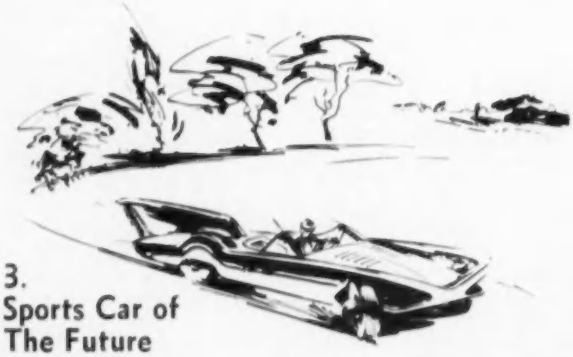
- **One of these might be a large, luxurious, high-speed Highway Cruiser for safe intercity transportation at ultra high speed, as shown in Fig. 1.**

- **The second type, the Urbanite, in Fig. 2, will combine maximum passenger space and maneuverability in a small package. Design simplicity and medium speed performance will be its hallmarks.**

- **The third type, suggested by Fig. 3, will be a sports car to travel over secondary roads to recapture the thrill of driving for pure fun.**



2.
The Urbanite



3.
Sports Car of
The Future

# Bodies

## by Harry E. Chesebrough

### 1. The Big Car Package

And now to conjecture on the effect of this environment on automobile styling. To start, let us look in detail at the Highway Cruiser. It will be somewhat lower and wider than today's cars, and will be larger than today's cars . . . a big car to do a big job. With a much lighter, somewhat smaller powerplant than we know today, it can have rear engine drive to give a flat floor. That will also permit it to have more optimum aerodynamic shape, and will better isolate the passenger compartment from powerplant and drive train noise.

Windows will be flush for aerodynamic cleanness and sealed because the vehicle will be air conditioned. The vehicle will be highly streamlined for minimum power requirement and also for stability in motion.

Propulsion might be turboelectric or direct-coupled turbine with power transmitted to all four wheels under conditions of straight ahead operation. There are prophets today who see the solution to the manifold problem of car control and safety through the use of electronic and electromechanical devices for obstacle warning, deceleration, and guidance.

The passenger compartment will have spacious accommodations for six people, with movable seating (instantly locked in place by an emergency warning system), and a transparent roof. Some designers rule out the steering wheel as we know it today, and believe that manual guidance might be accomplished with a small lever.

Although high acceleration will not be one of the necessary attributes of this vehicle because of its size, weight will still be a problem in its design. To help in its solution, light metals may be used extensively along with new structural techniques. It also is conceivable that a different type of glass will be used, something with more structural strength and less weight. Some stylists expect to depend on this for structure above the belt line and perhaps to obtain privacy and sun protection by activation of a molecular film in the glass structure.

### 2. The Small Car Package

The Urbanite will be a smaller, less complicated car, probably not so removed in concept from the cars we know today. It will have capacity for four people in fixed seats, and might be about the size of today's low-priced cars, although lower in height. The powerplant may be located in the rear to give a flat floor. The drive will be to the two rear wheels only. This would be a medium speed car for general use. Acceleration will be one of its main features, so lightweight will be important. Again, this may be achieved through extensive use of light metals both in the body and in the drive train, and the ultimate in streamlining for low power requirement.

The car will be equipped with many power controls and, if not with automatic guidance control, perhaps with obstacle warning devices. The medium cruising speed will limit it to the assigned speed lane of the expressways when it travels on them. But generally, the vehicle will be used for running errands in suburban areas. This car also will be air conditioned and quite possibly will have a transparent roof. The use of new types of structural glass might make this possible.

### 3. The Sports Car

The specification of the sports car is left to your imagination. We can be certain that it will be highly maneuverable and will have manual controls,

high power-to-weight ratio, and outstanding roadability. It will have roll-up windows, bucket seats, and a hard top which is readily removable.

Consideration of the specifications of these cars indicates that the chassis engineer too will be faced with many new and challenging problems in suspension, drive train, and brake design, powerplant mounting, automatic controls, and many others.

It appears that the aerodynamic requirement for optimum engine size and fuel economy will dictate clean exterior surfaces featuring flush door handles and trim, blended contours, and greatly reduced ornamentation. The structure will probably be an expanded "space-frame" chassis with aerodynamic, stressed panels. It is conceivable that powerplants of this era will not require replenishable liquid fuels. But if they do, it will be carried in flexible fuel cells built into otherwise unusable space in the body structure. The Highway Cruiser especially will require an ample luggage compartment.

In the Urbanite we might see a metal-roofed convertible in addition to the transparent "bubble" type roof. And, according to some current thought, in this car, as well as in the Highway Cruiser, the steering wheel and the column would be eliminated because it is felt they impose too many restrictions on seating arrangements and interior styling. Power controls would permit a different type of control panel. The interior of these cars would, of course, incorporate many safety features.

In the field of materials we should see the expanded use of light metals—aluminum, magnesium, titanium, and possibly even some we don't know commercially today. Molded plastics may find their place in panels subject to bumping and abrasion damage. The majority of body surfaces that are not glass may either have a permanent surface finish, or perhaps a permanent color incorporated in the material itself. Still another possibility is an indestructably applied surface coating, such as a tinted oxide film.

A new type of glass or a kind of transparent material with all of the present qualities of glass plus the added quality of structural strength and reduced weight may make its appearance. And, as previously noted, some visionaries believe this material will incorporate a molecular film which can be activated by a high frequency or magnetic field to polarize it in such a way that privacy and sun protection can be obtained. The interiors of these cars, in addition to offering comfort and safety, will offer durability and color effects beyond anything we know today. They will come from the extended use of synthetic fibers and molded, rolled, or extruded shapes of new miracle resins upon which chemical research is even now at work.

We will see equally wonderful improvements in manufacturing methods. Automatic machine tool cycles, electronic and punched card scheduling of operations and control of machine processes will make possible volume production with broad flexibility. All of these and many more processes properly applied will make possible the maintenance of the high degree of uniformity and reliability that will be required of these complex mechanisms.

### New Horizons

Although much of the above may sound visionary, nothing here is really outside the scope of present day knowledge. In fact, many of these developments are already in use in other fields, and require only some basic applications studies and cost reduction work to make them feasible for automobiles. For example, an electronic guidance and control system that has been developed by a major company of high repute could possibly find automotive use some day. No part of the automobile mentioned here has not undergone at least as great a change in the last 25 years as those described above. We are living in a universe which is expanding physically as well as intellectually. The rate of expansion is constantly accelerating under the pressure of human need and scientific research. Viewed through today's perspective, yesterday's achievement becomes the yardstick by which we must measure tomorrow.

So let's look at the achievements of yesterday and today, tomorrow's yesterday, which are the prelude to the future.

## II. HISTORIC BEGINNINGS: Marrying Art to Engineering

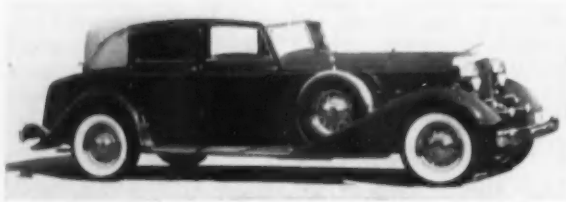


Fig. 4—A custom-bodied classic of the early thirties, the 1933 Chrysler Custom Imperial Limousine

The colorful 25 year history of the SAE Body Activity has paced the spectacular rise of passenger car body engineering to a position of vital importance in the automotive industry. With this progress we have seen the development of an entirely new professional branch of automotive engineering —Body Engineering—and a whole family of related materials and methods technologies. It is of interest to note that the industrial design profession also began to play a major role in automotive design

about 25 years ago, although it had been developing as the classical meeting ground of art and engineering since the time of da Vinci. Today the area of industrial design concerned with automotive styling is a major determinant in the very competitive automobile sales picture.

No remarks on the beginnings of the SAE Body Activity would be complete if they did not include the fact that the first SAE National Body Activity meeting was conducted in January, 1930, two years after the founding of the SAE Detroit Section Body Division. However, interest in body engineering goes back 41 years to 1914 and the presentation of the first SAE technical paper on body engineering by a pioneer named Hinsdale Smith, of the Springfield Metal Body Co. Smith's subject was, prophetically, "Tendencies in Body Design," and he predicted streamlined closed bodies and popularity for the two-door types.

Prior to the 1930 era the automotive industry had struggled with indifferent success to establish itself as an integral part of the transportation system of the nation. In those early days emphasis had to be placed solely on mechanical development and basic dependability of the vehicle. Twenty five years ago it appeared that the ultimate goal of basic dependability had been reached. The average automobile was then equipped with a high-speed engine with a stupendous output of 55 hp at 2200 rpm. It had four-wheel brakes, a three-speed transmission, double-acting shock absorbers, electric starter, and cord tires. Who could want more? Only the 23 million people who then comprised the car-buying public!

In the 25 years since then these people have been joined by approximately 25 additional millions who have demanded more from the automobile each year. In 1930 it was no longer adequate to reach one's destination without incident; this had been done before. To yesterday's thrill of arriving had to be added the pride of not reaching there appearing as if one had been on an expedition.

With the coming of the Thirties, automobiles were recognized as important transportation tools for everyday living. Drivers wanted the convenience and comfort which had long been admired in the custom bodies built by some of the great body builders whose names are now part of history . . . names like Judkins, Bowman and Schwarz, and Willoughby. Fig. 4 shows a classic of the early 1930's, the 1933 145½-inch wheelbase custom-bodied Chrysler Imperial Limousine.

Derham and the few others who remain are examples of a prosperous group of small companies who made great contributions to the early development of the body builder's art. These companies contributed directly by bringing into existence those magnificent old bodies we all remember. But, perhaps more importantly, they contributed by creating a mass desire for the comforts and features of their work among the great car-buying public. Such popular demand for style and comfort brought about the development of what we now call Body Engineering to work out suitable designs for the constantly improving methods, materials, and machinery of the production plants.

Please turn page

## SAE Golden Anniversary Author

Harry E. Chesebrough

**Harry E. Chesebrough is chief body engineer for Chrysler Corp.** He has been with Chrysler since 1932, when he joined as a student engineer.

Chesebrough was born in Ludington, Mich. He studied at the University of Michigan and received his bachelor of science degree in mechanical engineering there in 1932. From 1932 to 1934 he continued his studies at the Chrysler Institute. Upon completion of his training period he was assigned to the mechanical laboratory, where he did development and testing work on car parts. Later he had charge of the Transmission Laboratory for two years, assisting in the development of overdrives and the Fluid Drive. In his next assignment, in charge of the road test laboratory, he was responsible for coordinating Chrysler's early development work on tanks.

In 1942 he was transferred to the DeSoto Division and put in charge of engineering for the aircraft program. Subsequently he served as chief engineer of both DeSoto and Dodge Divisions before being transferred to Chrysler central engineering's body and styling sections in 1950. He was advanced to assistant chief body engineer in 1951 and is now chief body engineer.

Chesebrough was SAE vice-president representing the Body Activity in 1953. He has been an active member of many technical committees and is now chairman of the Meetings Committee and a member of the Public Relations Committee. In Detroit Section, he was secretary in 1952, vice-chairman in 1953 and is chairman for 1954–1955.

## III. RECENT PROGRESS: The Expression of Function

Looking back from 1955, it is a chicken-or-egg question whether market demand, competitive industry, or progress in applied science accelerated automotive developments. But the years after 1930 saw a continuous array of innovations in all automobiles, innovations which contributed to comfort, safety, durability, and economy. Examples of these with which we are all familiar include all-steel construction, heat-absorbing laminated and tempered glass, sound and vibration controls, seating that gave a good ride for the life of the car, ventilation and air conditioning, corrosion proofing, improved paints and plated finishes, and miracle synthetic fiber fabrics. Such developments are standard equipment or optional features on almost every car today.

There is one thing more, an intangible which every automobile of today can boast. That thing is style. Today no automobile reaches the public which is not the result of careful, directed effort by a corps of skilled artists, working to bring functional beauty to every element of the body.

Such progress was both forced and aided by development of materials and techniques of fabrication which made yesterday's impossible today's commonplace. Here are only a few of the more important ones: safety glass curved at small radii; deep-drawing steel which permits large intricate stampings; high elongation stainless steel; synthetic rubber which will withstand long exposure without age hardening or permanent deformation; adhesives which will bond virtually any two materials together; paints and other finishes which retain their surface brilliance and are easy to apply and service.

We could not build today's automobiles with materials and tools of 25 years ago, and we shall not be able to build the automobiles of 25 years hence with today's materials and tools. That is what progress means.

### Chassis Influence

It is worth noting that many basic mechanical improvements were stimulated by developments in the body field. For example, as standards of quietness and performance rose, overdrive transmissions were introduced to control engine noise through reducing engine speed at high car cruising speeds. Powerplant output and smoothness gradually improved through engine and transmission refinements which provided lower axle ratios and greatly reduced engine noise.

Improvements in body silencing also made changes necessary in engine intake silencers and exhaust systems. Improvements in seating emphasized the need for better suspensions, and the high speed comfort such features made possible necessitated the development of power brakes.

## IV. STYLING EVOLUTION:

## From Horse to Horsepower Functionalism

Coincident with these product improvements came developments in the technique of body engineering which stimulated the greatest single production feature in the body field today . . . STYLE. The great designer Sullivan was right, early in the century, when he said that in good design, form does follow function.

From horse-drawn origins, automotive styling evolution has moved progressively through several style phases. Borrowing some handy nomenclature from natural history, we might call the first of these the Primitive, or horse-drawn without the horse, which passed into the Early American phase in about 1907. Fig. 5 presents a true Primitive, the 1892 Duryea, first gasoline-propelled car in America, carrying a typical horse buggy body. The 1908 Winton 6-16 touring car in Fig. 6 represents the 1907 Early American era.

This was followed by the Neo-Mechanical in about 1915, during which period open cars gave way to closed styles. Figs. 7 and 8 show the evolution of Dodge cars from open touring types in 1914 to closed, all-steel sedans in 1924. After this, the Paleo-Modern, or skirted-fender and sloped grille era came in about 1932. The 1932 Graham Eight Blue Streak in Fig. 9 helped to usher in this "streamlined" era.

Next came the Meso-Modern in about 1938, distinguished by such cars as the elegant 1938 Cadillac Sixty Special in Fig. 10, with bustle-back bodies and blended fender and grille forms. Today, of course, we are working in what might be called the Neo-Modern or unified shape period, exemplified by the 1955 Chrysler New Yorker DeLuxe sedan in Fig. 11.

Somewhere during the Neo-Mechanical period after World War I, when it began to be obvious that the horse was finished, and that the automobile was going to be reliable and someday, perhaps, even comfortable and beautiful, the automobile began to assume the status of a symbol of social prestige, a sort of icon of modern technology that nearly everyone could afford to enjoy.

This brought art, or styling, as it has come to be

## In 1892, cars looked like this . . . . .

Fig. 5—From horse-drawn origins, the first gasoline-propelled car in America, the 1892 Duryea

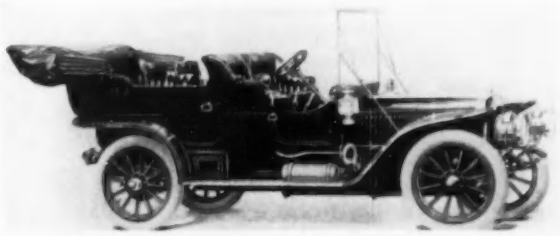


Fig. 6—An early American, the 1908 Winton 6-16

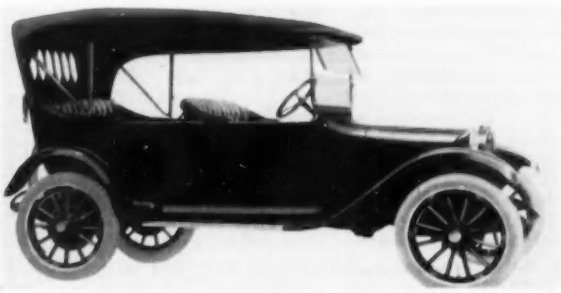


Fig. 7—Typical touring car of the Neo-Mechanical Era, the 1914 Dodge

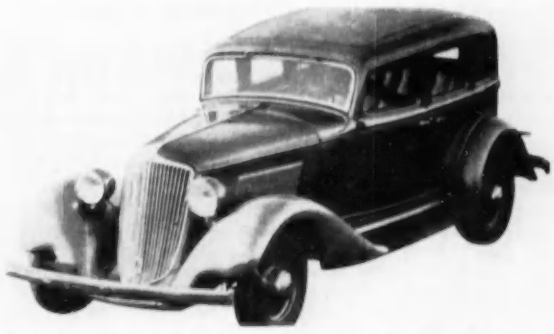


Fig. 9—The 1932 Graham Blue Streak—streamlining begins to come of age

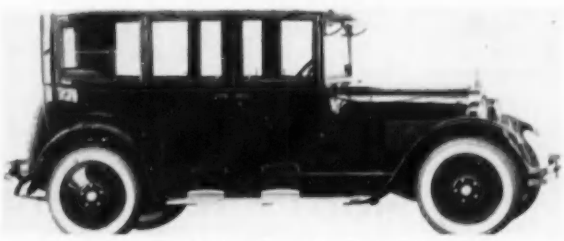


Fig. 8—An early closed car, the 1925 Dodge sedan

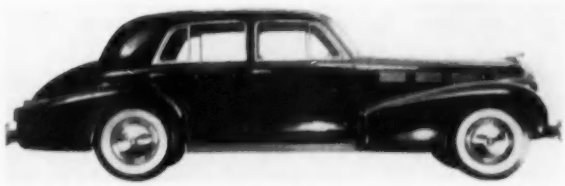


Fig. 10 —A significant Meso-Modern car, the bustle-backed 1938 Cadillac Sixty Special

## By 1955, cars looked like this . . .

Fig. 11—A recent example of unified shape styling, the 1955 Chrysler New Yorker DeLuxe

# Premise for Prophecy

Trying to look into the future is at best a difficult business, and it is particularly so when the field of one's interest has consistently shown such tremendous rates of advance as has the automotive field.

On the one hand, realistic conservatism suggests today as it did in 1930 that, after all, the modern automobile is a pretty complete piece of machinery —reliable, economical, beautiful of line, powerful —and definitely integrated into today's modern industrial society. On the other hand, we know that development is taking this "perfect" automobile nearer perfection every day, and that each year sees new goals of safety, performance, comfort, and reliability reached and others reestablished. It is like climbing a mountain that gets steeper and higher as we climb, and yet getting stronger and more sure-footed as we ascend.

Attempts to look ahead are helped by the wealth of educated speculation and prophecy, as well as the as-yet undeveloped achievements of science and technology which may find application in tomorrow's cars—from all this material one can build in his own guesses, and in that sense these predictions are offered.

The current emphasis on styling is not unique to the automobile market, though it may be said to have begun there if one discounts the fine art field where furniture, jewelry, objets d'art, and interior decor have always dwelt. It is part of an industrial movement which has grown to embrace the whole spectrum of consumer goods from pencil sharpeners to dump trucks. To be competitive, everything must have style now. We live surrounded by devices and environments which have been touched by the artist or industrial designer. However, nowhere else has such keen product discrimination been developed as on those facets of consumer desires which concern automobiles, where product performance and art are brought to powerful focus. Styling has accomplished this, and in doing so has introduced the style-conscious American woman as a key element in the competitive sales picture.

This is all part of a basic natural process, civilization, which is itself largely concerned with improving and making appealing the things we use in controlling our natural environment. Automotive styling, and the larger field of industrial design, are not new forces. They have merely been accelerated currently by the interruptions of two world conflicts. Industrial civilization is catching up.

To understand better the detailed styling problems of the future, let us try to construct the environment in which many feel the stylist of the future will work. The continuing progress of the automobile may well have changed the pattern of urban and suburban living until our country may be criss-crossed by a network of limited access expressways. Our cities may have exploded from the internal pressure of traffic and crowded living in industrial areas so that it might become fairly commonplace to travel 75 to 100 miles to go into the city on the infrequent occasions when it is necessary. The drawing shown here suggests one artist's conception of the appearance of such a city.

Personal radio communication may well be universal, and in stationary installations might feature a televised picture of the person on the other end of the line. Our homes, offices, and automobiles will be air conditioned the year 'round. And, there are prophets who today are saying that automatic safety controls will be available so that on the expressways one will be able to lock into a directional steering channel which will take over guidance of the vehicle.

called, into the picture. As early as 1920 in the more progressive companies, art and color men, whose activities today have grown to become sections or divisions, were at work first to remove awkward lines and mechanical excrescences with which the exteriors of pre-1930 cars bristled. Later they were to blend the basic shapes of the automobile into the integrated forms we know today.

Progress in body styling of the past 25 years seems all the more remarkable when viewed in the light of the fact that body design began on a horse-drawn precedent with the advent of the automobile. The body designer's job remained much the same as the carriage maker's had been—to carry people, protected from the weather and in comfort. It made no difference whether steam, gasoline, or oats provided the power.

This is why anachronisms like whip sockets, fringed tops, and high wheels remained to make automobiles truly horseless carriages long after the horse had passed, and why chassis development made relatively greater strides than body advancement before the awakening about 25 years ago of the modern school of body styling. In retrospect, evolution since then seems to have been so clear and logical and trends so obvious that it is easy to be tempted to predict the future, as we have.

The chassis designer, on the other hand, faced

the automotive era with fewer precedents to limit his work, with only a few principles of mechanical design and the functional requirement before him. The result was rapid progress in engines, transmissions, and suspensions, as evidenced by the fact that the multicylinder V-8 engine, selective transmission, shaft drive, electric generator, and four-wheel brakes had all made their appearance before 1911, while the body was yet nothing more than a pair of open seats and a crude folding top.

## V. STYLING TODAY: New Tools and Techniques A-borning

Fig. 12—Wooden body construction of the 1915 era

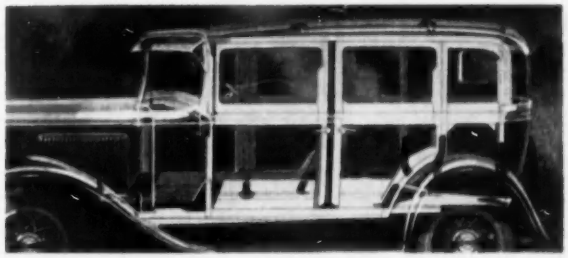


Fig. 13—A typical wooden body structure of the early Thirties

As body designers have changed, so has the professional picture. In place of the draftsman and woodworker of yesterday we now have specialists in styling, surface development, structural and mechanical design, and in a variety of sheet metal tool and production processes.

Early bodies were principally of wood built from simple patterns on crude assembly jigs and covered with steel or aluminum panels. Figs. 12 and 13 show the methods and design of early and late wooden body manufacture. Steel construction changed this somewhat and drawings and lofts or drafts were required, but the drawing work was more of a mechanical variety. Gradually, surface development techniques evolved and reached their present advanced state of refinement.

As shapes became more complex and style more important, the creation of the body surface in clay was added to the system. And now when the demands of the stylists sometimes produce situations with which the engineer is as yet unable to cope, the designing and styling are carried along simultaneously so that mutually satisfactory compromises can be reached.

In recent years the plastic reproduction process has entered the picture. It promises to cause a major revolution in the technique of producing body engineering drawings and models. Early attempts made to use this new tool have been more along the line of supplementing the existing schemes of clay, templates, surface development, construction drafts, detailed drawings, and die models. Some of these processes may be eliminated entirely by the proper application of new techniques of plastic and photographic reproduction. This promises to reduce the time required to get the stylists' ideas reduced to product drawings and to improve the accuracy and uniformity of the final result.

# Plastics for Tooling . . .

**. . . are finding more and more uses. There's practically no limit to what can be done with epoxies, polyesters, phenolic resins, and glass fiber reinforcement.**

Based on presentation by **A. A. Merry, G. T. Huxford, and J. B. McCarry,** Pratt & Whitney Aircraft

AT Pratt & Whitney Aircraft, punches and dies with plastic facings are increasing in popularity. And plastics are used for kellering patterns and other patterns, for checking or holding fixtures, gages of many types, and various other kinds of tooling, and even for coolant pans for electric arc machining.

Fig. 1 shows how a plastic-faced punch and die are made. First step is to make a plaster mold of the outside of the model part or pattern. Turn this mold cavity side up. If the prototype part can be spared for punch making, leave it in the plaster. If not, build up the equivalent of the metal thickness with bees-wax or sprayed lacquer.

Coat the surface representing the part with a

parting agent. Then lay up glass fiber cloth impregnated with epoxy resin for a thickness of $\frac{3}{8}$ to $\frac{1}{2}$ in. This becomes the punch surface when it has hardened.

Into the punch cavity, pour enough potting resin to form a layer about 1/32 in. thick. Lower the previously prepared metal backup support gradually into place in the potting resin. The weight of the support pressure-molds the die securely to the backup.

The die is made up the same way, except that in this case the plastic is floated into the backup.

For male corner sections where the plastic may compress beyond tolerance or crush, it's wise to use metal inserts. Cut out the plastic corner. Contour a metal plug suitably. Then secure it to the remaining plastic form with potting resin.

## Plastic Trim Dies, Too

The plaster mold cast for the making of the punch and die can be used again to make an inexpensive set of dies to hold the part for trimming. Fig. 2 shows how. For this, use a casting resin. No glass fiber reinforcement is needed.

Cast a plastic lower nest and bond it to a kirksite backup. Add a plastic-faced kirksite or iron leaf for clamping the part.

Then mount the top shear blades on a conventional iron or steel top shoe, independent of the leaf. Mount the nest and bottom shear blades on the bottom shoe.

The fact that plastics bond to metal makes them useful for other tooling purposes. A plastic kellering pattern can be made complete on a surface plate, ready to put in position on the kellering machine. This is the cheapest way to make a good kellering pattern.

Plastic patterns are tough, light weight, and insensitive to temperature changes and moisture, besides.

Plastic has been joined to a metal grinder platen to form a coolant pan in one of Pratt & Whitney Aircraft's most novel applications of the material. The pan makes it possible to submerge pieces being electric arc machined on a Brown & Sharpe cutter grinder.

To form the pan P&WA tool men took the platen off the grinder and placed it on a stone layout plate. Around it they constructed a core box. They built up the surface of the box with plastic to represent exactly the desired contour of the inside of the pan, then smoothed it carefully and applied parting compound.

To prepare the metal platen for bonding to the plastic, they degreased and grit blasted it to insure a clean, smooth surface.

Then they laid up glass-reinforced epoxy resin over the core box and platen, forming the actual coolant pan. Final step was to bond a pipe flange for a drain to the plastic coolant pan with epoxy paste.

The several coolant pans made this way are standing up well in use.

(This presentation was made by Mr. Merry at the panel on Improved Manufacturing Methods held as part of the SAE Aeronautic Production Forum, New York, April 12, 1954.)

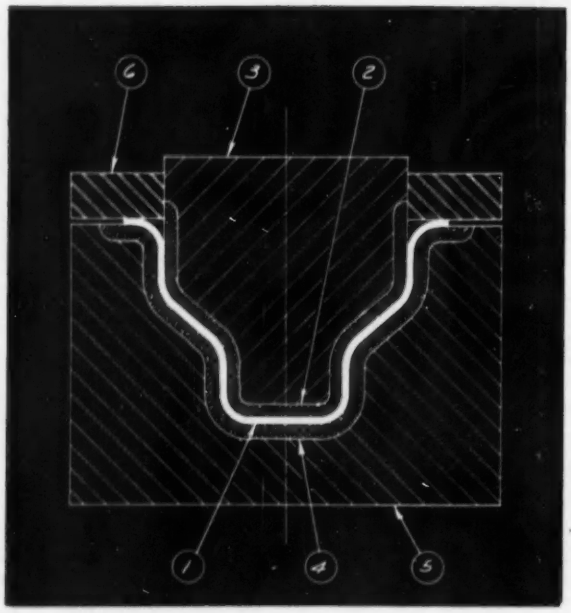



Fig. 1—How the plastic punch and die are constructed

1—part
2—punch surface
3—punch backup
4—die surface
5—die backup
6—pressure pad

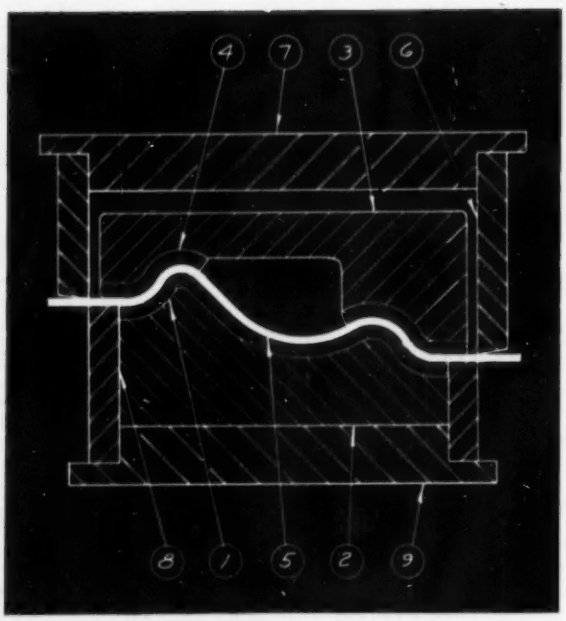



Fig. 2—How the plastic trim nest is constructed

1—cast nest
2—backup
3—leaf
4—facing
5—part to be trimmed
6—top shear blade
7—top shoe
8—bottom shear blade
9—bottom shoe

# High-Speed Flight Has Its Own Special Problems

**Earle S. Hodder,** Aerodynamics Supervisor, North American Aviation, Inc.

Excerpts from paper, "Problems of High-Speed Flight," presented at the SAE National Aeronautic Meeting, Los Angeles, Oct. 8, 1954.

SINCE World War II, many new stability, control, and operational problems have arisen as a result of the demands for higher aircraft speeds. Some of the more important ones will be discussed here. They are:

1. Wing drop.
2. Pitchup.
3. Unaccelerated stability.
4. High landing speed.
5. High rate of descent.

## Wing Drop

Wing drop is common to many airplanes in operation today. In general it occurs near the drag rise and is the result of compressibility effects. As the airplane Mach number is increased into the transonic range normal shocks will occur on the wing. Since surface irregularities can cause the shock to occur earlier than would happen on a perfectly smooth section, one wing panel generally shocks before the other, due to the small differences encountered as a result of manufacturing tolerances. This shock is accompanied by a flow separation extending downstream from the shock. This separated flow results in a loss in lift and consequently a "wing drop" or "roll off" in the direction of the wing first encountering the shock. The wing drop tendency is generally further aggravated by deflecting the aileron to counteract the roll. This occurs because the "down" aileron required on the down-going wing tends to increase the upper surface negative pressure. This results in an increased shock intensity, with further loss in lift on this wing panel. Of course, since the conventional aileron control is operating in the separated flow region, its effectiveness is relatively low, which further complicates the problem, particularly for the pilot.

The entire wing drop problem is further aggravated by wing twist resulting from the aileron deflection. This condition makes the wing drop become more severe at low altitude and, depending on the wing stiffness, may actually limit the maximum speed of the airplane. This would be particularly true of airplanes designed to low limit load factors, such as bombers and transports.

The current trend in supersonic airplanes is toward thinner and thinner wings, at least as evidenced by the fighter-type design. This probably means that the supersonic fighter airplane will not

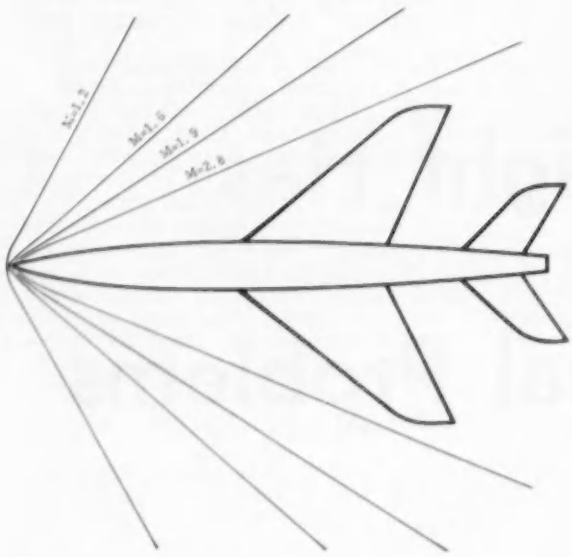



Fig. 1—Shock-wave pattern

have the wing drop problem, since shock waves are more severe on thick wing sections than on thin ones. In so far as bombers and transport airplanes are concerned, even though comparable wing thickness to those mentioned previously are used, they may still encounter some wing drop tendencies. This could occur because of the generally relatively low wing stiffness of the bomber or transport compared to the fighter. For these aircraft, even a mild shock intensity differential between one wing and another, combined with a low torsional stiffness, might still cause some noticeable wing drop. The effect of the less rigid wing torsionally, of course, enters into the picture when the ailerons are deflected to counteract the differential shock effects on the wing.

Although it does not appear that wing drop as known today on the transonic airplane will be as serious on the supersonic airplane, there is possibly one other source of wing drop for the supersonic airplane. This source is the bow wave on the nose of the airplane. The airplane nose bow wave is shown in Fig. 1 for several Mach numbers on a plan view of a possible supersonic airplane configuration. These fuselage bow waves bend farther aft as the Mach number increases. At some Mach number, depending on the geometry of the airplane, the bow wave will intersect the wing. If the bow wave is not perfectly symmetrical, as might be caused by the airplane flying at a small amount of yaw, or for any other reason, the pressure and velocity changes through the shock may induce disturbances on one wing before the other. Consequently, it is possible that the bow wave, or asymmetric shock waves from any other part of the airplane forward of the wing, if severe enough, may create a new wing drop problem for the supersonic airplane.

## Pitchup

In pitchup (sometimes referred to as digin, or overshoot) the airplane suddenly pitches up or digs in during a pullup or turn to a load factor ($G$), which is considerably higher than the pilot intended. It is the result of shock-wave formation.

One of the original causes of pitchup was the elevator trim tab. The pilot would begin to dive, during which he continued to trim with the elevator tab to keep the stick forces comfortably low. Eventually, the airplane reached a speed where normal shock waves formed on the horizontal tail. The elevator tab was then operating in a thick boundary layer behind the normal shock. The trim tab effectiveness (its ability to trim out stick force) was very low. When the pilot began his pull-out from the dive the pull stick forces were very high, necessitating large amounts of nose-up trim (tab down) to lower the stick forces and aid the pull-out. As the airplane gradually increased load factor and pulled out of the dive, it slowed down until the speed was low enough over the tail so that the shock waves were minimized or else completely disappeared. This resulted in the tab effectiveness increasing back to its original high value, so that the tab forced the elevator up, causing a rapid pitchup before the pilot could do anything about it. It is not expected that this detail cause will give pitchup trouble on the supersonic airplane because no one in his right mind would use a conventional elevator tab system on a supersonic airplane. At least if he did, he would surely recommend that it not be used in the conditions just described.

A second cause of pitchup is shown by Fig. 2. Assume, for example, that the pilot is building $G$ (increasing $C_L$) at 1.2 Mach number. Assume that the airplane is flying in level 1.0$G$ flight at 0.1 lift coefficient and the pilot pulls up to 5$G$ (corresponding $C_L$ is 0.5). As the value of $C_L$ increases, the drag would also increase and the airplane would slow down to say, $M = 1.0$. If the stabilizer angle is held constant while the airplane slows down, we find that the pitching moment being overcome by the stabi-

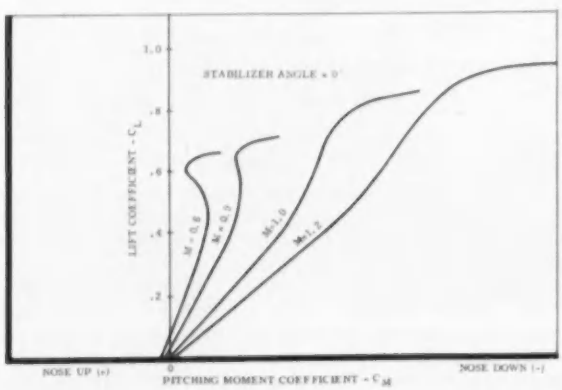



Fig. 2—Static stability—lift coefficient versus pitching moment coefficient

lizer is less negative at 1.0 Mach number than it was at 1.2 Mach number. In other words, a nose-up pitching moment is applied to the airplane due to the decrease in speed in the turn or pull-up, with the result that pitchup occurs. This has been a source of pitchup on the transonic airplane and will also be one on the supersonic airplane in the transonic range of Mach numbers.

This condition is further aggravated by the relatively low effectiveness of the stabilizer in the transonic range. This effect can be explained in a manner similar to that used above for the tab. The stabilizer effectiveness is lower at 1.2 than at 1.0 Mach number. Consequently, if the pilot is holding a constant stabilizer angle the increase in effectiveness when the airplane slows down will cause additional pitchup.

Actually, pitchup due to these latter two causes will probably not be too serious on the supersonic airplane, provided a good, powerful control is provided, such as the movable stabilizer, so that the pilot can stop the pitchup. It is also probable that pitchup due to these causes will not exist to any great degree at Mach numbers above approximately 1.5, since the aerodynamic center variation above this Mach number will be comparatively small.

One other source of pitchup is shown by the unstable (positive slope of $C_L$ versus $C_m$) or hookback portion of the curves for 0.6 to 0.9 Mach numbers between 0.4 and 0.6 $C_L$. If the $G$ is increased sufficiently to fly in this $C_L$ range, the nose-up pitching moment increment contributes to overshoot, even at constant Mach number. This cause of pitchup can generally be minimized and in some cases eliminated ($C_L$ versus $C_m$ curve maintained approximately linear to the maximum $C_L$) by proper selection of wing planform, wing leading edge camber, wing leading edge slats, which are open in this lift range, and in some cases by proper location of the horizontal tail with respect to the wing. Horizontal tail locations below the wing have been installed on some recent supersonic airplanes primarily for this reason.

## Unaccelerated Stability

Fig. 3 shows a typical plot of stabilizer angle required for various amounts of $G$ versus Mach number for a typical but ficticious supersonic airplane. The negative slope of the 1$G$ stabilizer angle curve is a measure of positive unaccelerated static stability, as were the $C_L$ versus $C_m$ data of Fig. 2. The region between $M = 0.85$ to 1.1 thus exhibits instability with change in Mach number, although data of Fig. 2 showed high positive stability at a constant Mach number. Fig 3 thus shows the same thing as Fig. 2, but is probably in a more understandable form, at least from a pilot's standpoint, since the airplane actually flys at each Mach number with the stabilizer angles shown. From the pilot's viewpoint the action of the airplane in the 0.85 to 1.1 Mach number range would be described as tucking. As he increased speed in level flight the airplane would tend to dive, requiring the pilot to pull back on the stick. The pilot's definition of positive unaccelerated static stability would then be that, as he increased speed, he would have to move the stick continually forward (stabilizer would move continuously in a nose-up direction with increasing speed).

This reversal of stabilizer angle with increase in speed may prove troublesome for the supersonic airplane if it cruises in this Mach number range. For this condition the pilot would trim the airplane "hands off" at the desired speed, say, $M = 0.95$. If the airplane encountered turbulent air, which caused considerable speed change, it would continue to wander from the trim speed. Assume in Fig. 3 that a gust was encountered which slowed the airplane from its cruise speed of 0.95 to 0.93 (indicated airspeed change of 7 knots at 40,000-ft altitude). Since the stabilizer angle (or elevator angle, if one is being used) would remain fixed at its trim position (pilot's hands off stick) the decrease in speed would cause the airplane to start a slow pullup to 1.2$G$. The increase in $G$ would further slow the airplane, causing it to pull up to a higher $G$. Thus, the airplane would continue to wander away from the trim speed, requiring constant pilot attention. However, cruising by use of an autopilot would be satisfactory since it would provide the constant attention necessary to maintain the trim speed. General flying by the pilot in this range would probably not be troublesome, although he would have to pay continual attention to maintain a constant speed.

The degree of change in stabilizer angle in this 0.85 to 1.1 Mach number range depends primarily on the wing planform shape and the airfoil section used. In some cases it might also depend on the horizontal tail vertical location with respect to the wing (tail undesirably enters wing wake at high $C_L$).

Another way of explaining pitchup due to changes in stability (increasing negative slope of $C_L$ versus $C_m$ curve) as a function of Mach number can be seen in Fig. 3. Assume that the pilot intends to pull 3$G$ at a Mach number of 1.0. For the airplane considered in Fig. 3 he pulls back on the stick to change the stabilizer angle from – 1.25 to – 3 deg. If he can maintain the Mach number constant by diving or increasing power, no pitchup will occur. However, if the speed, and hence the Mach number, decreases appreciably pitchup will result. For this example assume that the Mach number decreases in the pullup or turn to approximately 0.95$M$ while he is holding the stabilizer angle constant. From Fig. 3 it is seen that for the 3-deg stabilizer angle at a Mach number of 0.95 the airplane will be at

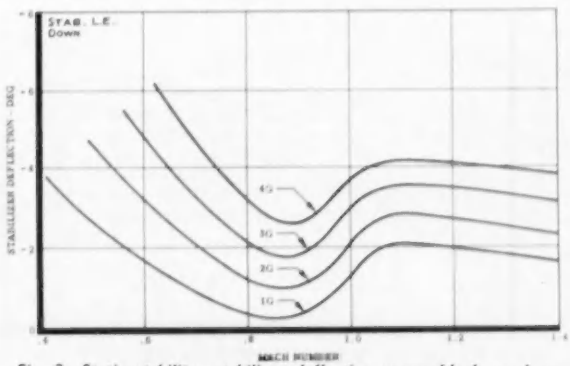


Fig. 3—Static stability—stabilizer deflection versus Mach number

### Adventure of a Test Pilot

AT the meeting, the problems of high-speed flight were vividly brought home by Brig.-Gen. B. S. Kelsey, deputy director of research and development, USAF, who was chairman of the session.

He described the disintegration of a P-38 that he himself had taken up to flight-test a dive recovery flap. "As I hit the selected dive speed at 31,000 ft," he said, "I began to experience difficutly in reaching and operating the dive recovery flap valve. While I was looking at the valve—as one inadvertently does under such circumstances—the airplane went into a dive.

"First I tried an unconventional recovery technique by rolling and kicking the top rudder. The trim tab, stabilizer, and rudder left the airplane, sending the plane into a spiral. I tried to straighten it with the engines, but it went over on its back. I decided the time had come for me to take my leave.

"I opened one canopy; however, as I reached for the other, the negative acceleration put the latch back in place. I tried again—prying up one corner of the canopy and opening the other latch. This time I succeeded. The canopy left and ejection was completed. As I floated earthward, I saw the airplane was also short one wing, a detail I hadn't noticed before."

4*G*, thus, it has pitched up an increment of 1*G* from the intended 3*G*. This can be a serious problem if much pitchup occurs, since structural limits may be exceeded. It would undoubtedly be more serious on bombers than on fighters because of the relatively low limit load factors. Since this pitchup condition probably cannot be completely eliminated, the next best thing that can be done is to provide the pilot with a longitudinal control surface of high effectiveness to stop the pitchup once it starts. This comment indicates that an all-movable horizontal tail should be used in preference to an elevator because of its relatively higher effectiveness.

## High Landing Speeds

Fig. 4 shows how the landing configuration stall speed ($V_{s_L}$) has increased with increasing maximum level flight airspeeds. All types of airplanes have been included from the Mooney Mite to the F-86. The stall speeds are plotted for a loading condition with approximately 10 to 15% fuel remaining.

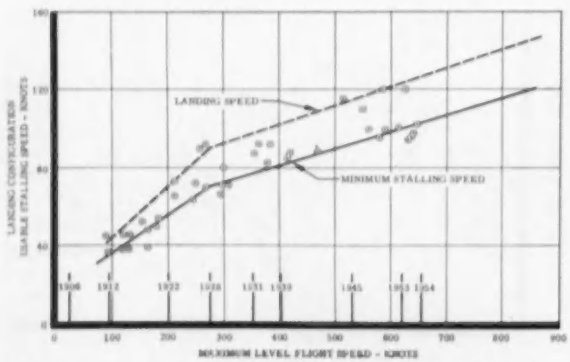



Fig. 4—Comparison of maximum level flight speeds and stalling speeds

The amount of braking which can be accomplished above 100 to 110 knots is relatively small. This low available braking, combined with the lift on the wings, detracting from the weight on the wheels, causes many blown tires before the pilot learns to take it easy on the brakes at high ground speeds. Thus, operational costs due to tire and brake wear are increased.

As a result of the higher landing touchdown velocities the airport runway lengths have continually increased. This means the airport construction costs are higher. At the end of World War II the average Air Force runway length was 5000–6000 ft. Today these runway lengths have been increased to somewhere near 7000–8000 ft and in some cases to as high as 10,000 ft. Of course, the take-off run at very heavy weights is probably equally as guilty as the landing ground roll for the increase in runway lengths.

The drag chute has done a very good job of decreasing the landing ground roll of the high-speed airplane. It is not difficult to pack and, if properly installed, it rarely fails to do the job for which it was intended. Reversed thrust is common on propeller-driven transport airplanes of today and undoubtedly will be common on some high-speed jet-propelled airplanes of the future. Flaps are still being used to decrease the stall speed and, hence, the touchdown velocity, but the gains are not enough to keep the ground roll distance from increasing as the maximum airspeed increases.

Boundary layer control by blowing or sucking air over a flap is supposed to be the cure-all of the future in so far as reducing the stalling speed is concerned. Boundary layer control has been looked forward to for years and it now appears that it is about to pay off. However, it will probably only

lower the stalling speed curve of Fig. 4 by 10%. This is a sizable gain but, in the case of the single-engine airplane, proper pilot indoctrination will be necessary to realize its gains. It is a well-known fact that many pilots of single-engine airplanes prefer to plan the landing pattern to ensure making the runway in case of an engine failure. This is particularly true of the average Air Force fighter pilot —at least those with a low level of experience.

In general the average pilot increases his landing touchdown speed above that recommended 5 knots for his wife and 5 knots for each of his children—and pilots seem to have at least 5 children.

It will be the duty of the manufacturer as well as the experienced Air Force personnel to indoctrinate the pilot as to the necessity of proper operation of these airplanes during landing. If this is not done a high rate of landing accidents will result.

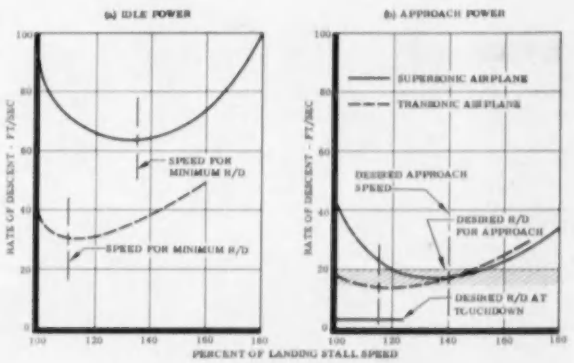



Fig. 5—Low-speed rate of descent

## High Approach and Landing Rates of Descent

The current trends of wing design for the jet-propelled supersonic airplane are to extremely low aspect ratio. The wing loadings at landing are 40–60 psf, which are fairly high and of the same order of magnitude as the present-day transonic airplanes. The combination of low aspect ratio and medium-to-high wing loadings also contributes to high landing speeds and subsequent long ground roll distances during landing. It is also this combination which makes it extremely difficult for the pilot to perform good landings with idle power or power-off. Fig. 5 shows rates of descent with both idle power and approach power for a typical transonic and supersonic airplane. The data are considered a reasonable representation of airplanes having a wing aspect ratio of 6 for the transonic airplane and 3 for the supersonic airplane.

Fig 5a presents the rate of descent for idling power. In both cases the rates of descent are in excess of the band of 8 to 25 fps considered acceptable by pilots. The rate of descent for the supersonic airplane is considerably higher than that for the transonic airplane because of the lower aspect ratio and higher wing loading. The speed for minimum rate of sink on the transonic airplane occurs at 120% $V_{s_L}$, which is approximately as desired, but for the supersonic airplane it occurs at 135% $V_{s_L}$. In both cases power approaches would be recommended to obtain the desired rates of sink.

Fig. 5b shows the rate of descent in the recommended power approach configuration for the two airplanes being considered. Sufficient power is applied to obtain the optimum rate of sink (17 fps) at the approach condition of 140% of the stalling speed.

The effect of power, as seen by comparing Fig. 5b with Fig. 5a, is to shift the speed for minimum rate of sink to a slightly higher value. This is undesirable, although for the particular cases shown the effect is small. Even though the optimum rate of sink is obtained by addition of power, one very undesirable feature still remains for the supersonic airplane. This condition can be seen from Fig. 5b, where the rate of descent increases for speeds less than the approach speed of 1.4 $V_{s_L}$. This implies that, if power is held constant during the approach, the supersonic airplane will have an increased rate of sink as the speed is decreased in the flare. Actually, if the landing flare is performed slowly, this is exactly what will happen. To decrease the rate of descent during the flare would require good timing by the pilot to pull sufficient $G$ to decrease the rate of descent and also judge the touchdown point just right before the airplane had lost much speed and the rate of sink began to increase. This probably means that the supersonic airplane of low aspect ratio and with approximately 50–60 psf landing wing loading will have to make power approaches at 150–160% of the stalling speed. This is necessary to ensure that as the pilot loses speed he can swap this kinetic energy for $G$ to flare the airplane and still have a little margin of $G$ and speed left. The speed margin remaining is necessary to take care of the case where the pilot first flares 10 ft off the ground and then has to do a little stick jockeying to feel for the ground.

In any event, this undoubtedly means many supersonic airplanes will be touching down at speeds in excess of the normal speed of approximately 120% of the stalling speed. This will result in undesirably greater landing ground roll distances and continual increasing operational headaches.

Things which can be added to the supersonic airplane to improve the shape of the rate of descent curve by shifting the point of minimum sink to a lower speed are as follows:

1. Wing flaps.

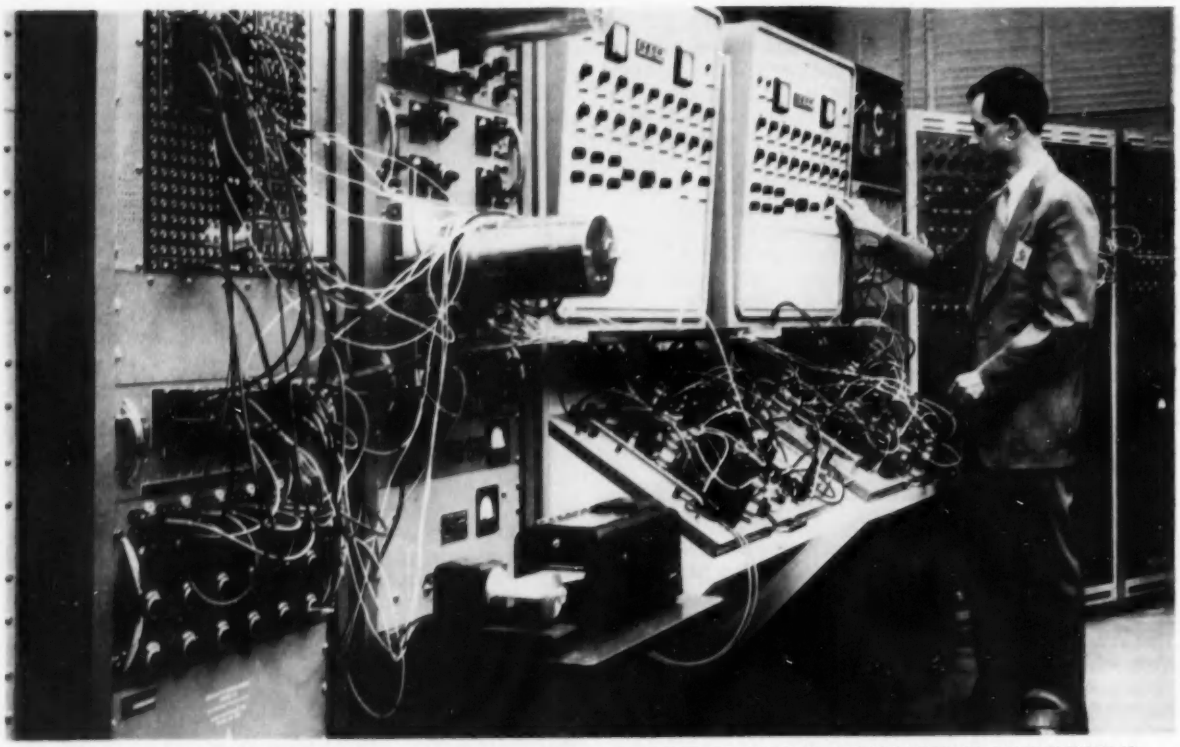
2. Drag items, such as speed brakes and an approach drag chute.

3. Large aspect ratio. (This is undesirable from the standpoint of high wing weight and wing flexibility or aeroelastic effects.)

4. Low wing loading. (This is very desirable but difficult to obtain and meet all the usual design requirements.)

5. Wing boundary layer control.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)



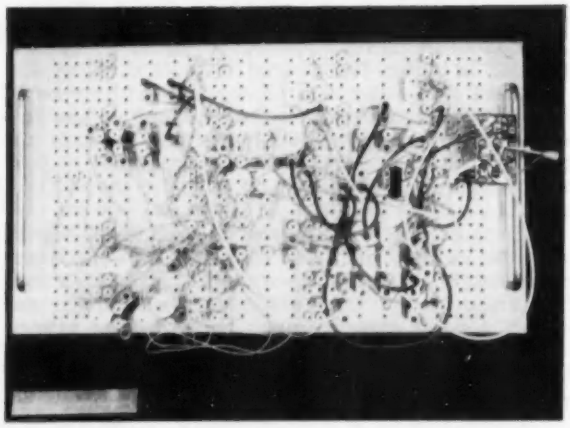
ANALOG AT BATTELLE MEMORIAL INSTITUTE HELPS ENGINEERS STUDY AUTOMOTIVE SUSPENSIONS

# Analog Helps Solve

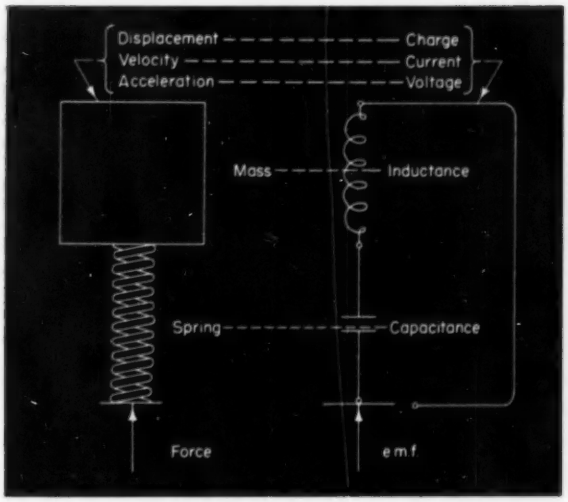
BATTELLE Memorial Institute is applying an analog computor to automotive suspension problems in a program sponsored by the Rockwell Spring and Axle Co. Early results of the work indicate that the analog can predict suspension behavior with reasonable accuracy.

Of course, the analog's answers are only as good as the theory and data fed into it. And for the sake of simplicity, some secondary factors are ignored. Therefore, results have to be checked here and there with experimentally obtained data.

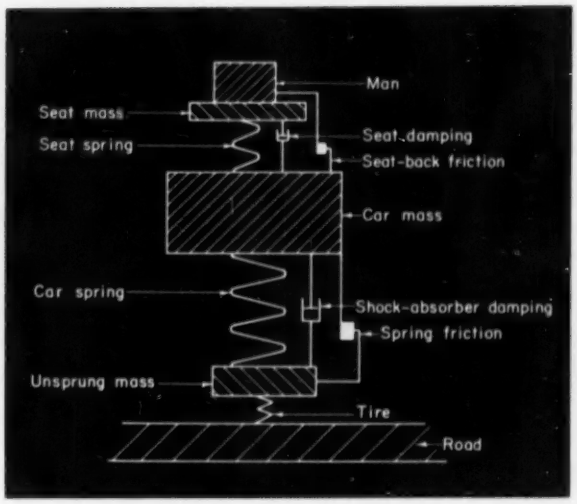
But the analog results are good enough, at least, to narrow down the range of cases to be investigated experimentally. This is all its users ask currently. They find this help well worth the time and expense of setting up the problem on the analog.



**PROBLEM IS SET UP** on this board. Electrical equivalents of tire, unsprung mass, seat mass, passenger mass, and springs plug in. Then analog is ready to attack problem.




**COMPUTER WORKS ON ANALOGY** between the electrical behavior of a capacitance-inductance system and the mechanical behavior of a spring-mass system. Electromotive force simulates a mechanical force such as road might exert on the spring via the tire.

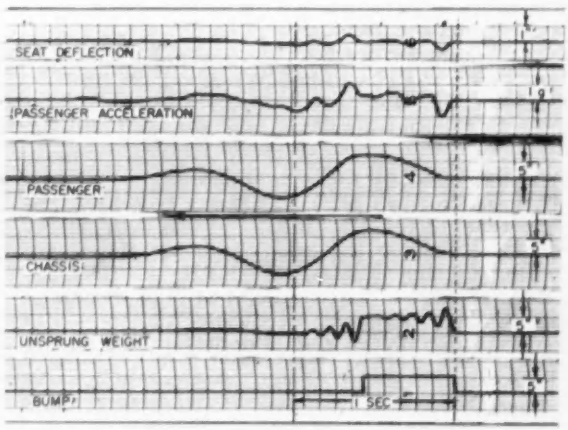



**FIRST ANALOG RUNS** were performed with this system. Idea is to apply the equivalent of a variable force at the "road" and look at the various portions of the system, particularly the rider, to see displacement, velocity, and acceleration. Then to vary seat parameters and recheck.

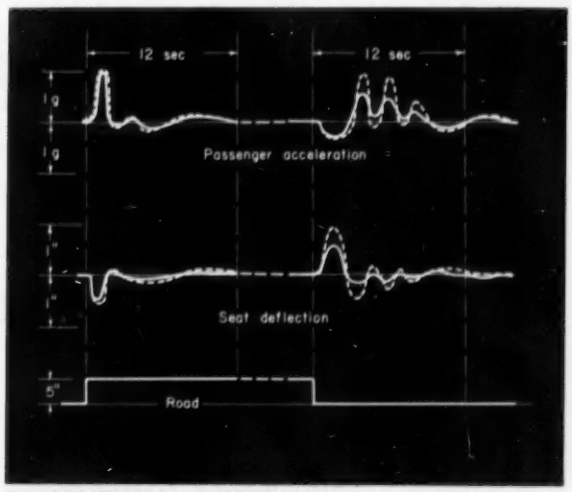
**Dr. Horace Grover,** Battelle Memorial Institute

Based on presentation before Round Table on Seating at the SAE Summer Meeting, Atlantic City, June 7, 1954.

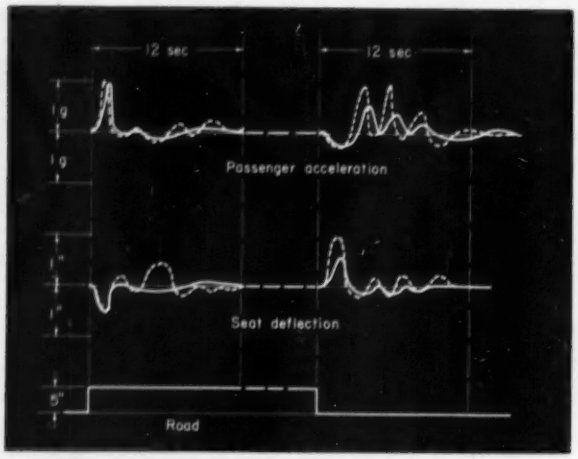
# Suspension Problems



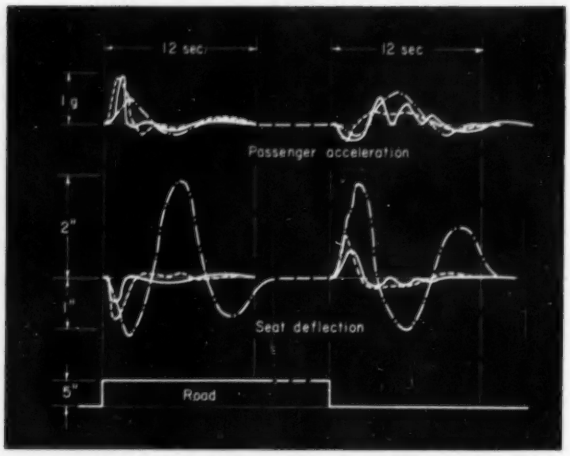

**OSCILLOGRAPH RECORDS** what happens when car goes over bump. (Curves read from right to left.) Unsprung weight oscillates. Insulated chassis and passenger deflect more gently.




**CONVENTIONAL SUSPENSION** is represented by solid lines. Dotted lines show effect of removing seat damping. Without cushion, rider gets more motion and acceleration.




**IF PASSENGER LEANS FORWARD** away from seat back (dotted line), he loses helpful damping of seat-back friction. Result is he experiences increased deflection and acceleration. (Solid line represents case with rider leaning back.)




**SOFTER-THAN-CONVENTIONAL SPRINGS** give much more deflection and somewhat greater acceleration, according to analog. Dot-dash line represents linear spring rate of 32 lb per in.; dash line, 125 lb per in. **RESULTS LIKE THESE MAKE . . .**

## Seating Experts* Say Cushion Design Grows More Exacting

Every year the stylist lowers the car roof a little and the seating engineer gets less room between the roof and the floor pan in which to seat the passenger. The tolerance in the positioning of the occupant narrows. The lower, thinner seat is called upon to do a more efficient job.

Designers can give the car body an excellent ride, then ruin it by the seat cushion. With some cushion designs, the rider's maximum acceleration is 2.5 times that of the car body. There's no sense to using the rider as a dynamic absorber to improve the ride of the car body.

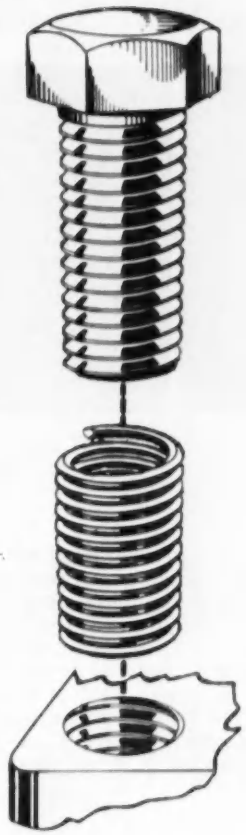
What it boils down to is that the cushion must filter out high-frequency dynamic disturbances and support the passenger in the proper static position.

The cushion ought to position the driver so that eye level doesn't coincide with the top of the steering wheel—and so that the steering wheel doesn't pin down his knee and make brake application difficult. Measurements on 100 national champion truck drivers showed that most of them are a little taller than the average truck driver but have much shorter lower legs. This may mean that they are better drivers partly because they are free to move their legs. If that's true, we might all be better drivers if vehicles were designed so that we all had this greater leg freedom.

From the physiological viewpoint, the cushion should be designed to support the body principally through the two bony structures known as the ischial tuberosities. They are built to take the load, and the area nearer the knee is not. Prolonged pressure under the knee can cause stagnation and clotting in the veins. This clotting is known medically as thrombophlebitis. It is potentially fatal because a dislodged clot, if it passes along to the lungs, can stop breathing due to a reflex. Because of the possibility of thrombophlebitis, one trend cushion design should definitely *not* take is increased support at the knee.

* Serving on the Round Table, besides Dr. Grover, were **D. J. Schrum**, Studebaker Corp., panel leader; **J. C. Gordon**, Gordon-Chapman Co.; **Dr. Albert Damon**, Harvard School of Public Health; **J. G. Haviland**, Fisher Body Division, and GMC; **Robert N. Janeway**, Chrysler Corp.

# Wire Screw Inserts Get Military Standards



**D. H. Secord,** Pratt & Whitney Div., United Aircraft Corp. and member of the SAE Engine and Propeller Standards Utility Parts Committee E-25.

MILITARY Standards for helical coil, wire screw thread inserts have been developed by SAE to replace over one hundred different sets of company standards that have been used in the past. This was done at the request of the military services to unravel the confusion of conflicting standards for this small, comparatively simple and widely used part. The potential value of the new standards to both military and industry can best be illustrated by examining the many uses of wire screw thread inserts.

The helical insert is a light weight, and compact successor to the old style thread bushing for use in soft metals where wear resistant threads are required. While it resembles a spring, it is actually a helically coiled, precision formed thread. As received from the mill, the round stainless steel (18-8) wire has a minimum of 150,000 psi tensile strength. It is then formed to a diamond-shaped cross section using specially ground carbide rolls, with a surface finish of 4 to 6 micro-inches.

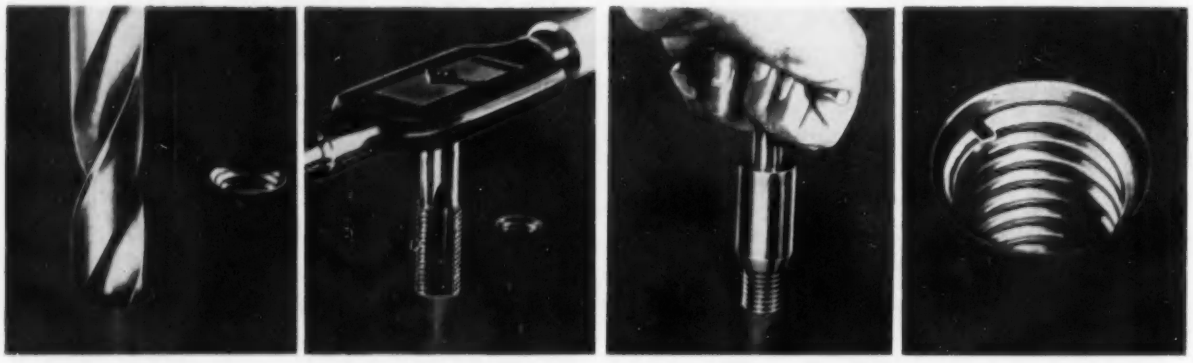
The finish obtained on the wire during the rolling process is from 8 to 15 micro-inches, which assures a smooth, free-running thread. The wire is cold worked during this process and the final wire strength runs from 200,000–230,000 psi, which tests on the Rc scale between 43 and 50.

After the wire is rolled, it is wound into small springlike coils which are held to a total tolerance of .0002 in. across the flats.

The combination of hardness, density and high surface finish of the wire insert protects it against corrosion, galling, and seizure. This is particularly advantageous where the assembly is exposed to high temperatures. Internal threads in magnesium and aluminum, and external threads on plated bolts are protected from unnecessary thread wear and corrosion by this smooth finish.

Certain corrosion resistant and heat resistant steels used in today's jet engines cannot be tapped with a sufficiently smooth surface on the thread flanks to resist thread seizure. But the wire thread insert has a thread flank smoother than can be obtained by any other method. So tapping directly

## Installing The Wire Screw Thread Insert



(1) Drill (2) Tap (3) Install (4) Restored Thread

(1) A hole is drilled to the required minor diameter, or else damaged threads are reamed out. (2) Hole is tapped to specifications. The tap is standard in pitch, but cut with an oversize pitch diameter to accommodate the insert. Class of fit tolerance of the final assembly depends on the tolerance to which the hole is tapped. (3) A hand inserting tool (or power tool for high production quantities) grips a driving tang for inserting into the tapped hole. A slotted mandrel in the tool engages the driving tang and winds the insert through a threaded tip, compressing the coil so that its diameter is slightly smaller than the diameter of the tapped hole. Mandrel rotation is continued until the insert is wound fully into the tapped hole. (4) The springlike action of the coil expands the insert into the tapped threads when the driving torque is removed. The coil has then seated itself into place and it will not move when assembling or disassembling the screw or bolt.

into the parent metal of a flange is possible. This can save space and weight by eliminating the need for longer bolts to accommodate nuts.

Wire thread inserts have been used in airframes and engines for over 10 years to provide strong threads and prevent wear in threaded holes. For example, one military aircraft uses 389 such inserts in an airframe.

One of the problems of specifying tapped holes in complicated and expensive aircraft parts is the danger that any damage to the thread would require the entire part to be discarded. But the wire thread insert, being considerably harder than most bolts and screws resists damage to the thread during assembly. Also, any damaged threads can be salvaged by tapping the hole slightly oversize and installing a standard wire screw thread insert. The piece will be as good as, or better than, the original.

Besides being used to repair worn or stripped threads, and to protect tapped threads in materials like aluminum, magnesium, wood and plastics, wire screw thread inserts have many more uses.

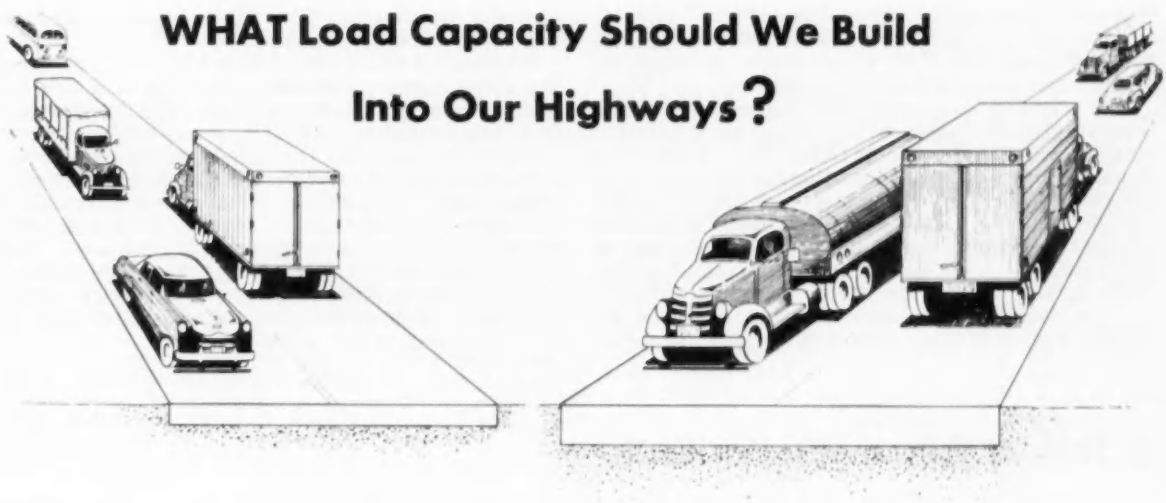
Aluminum lubricating pumps in high pressure air-compressors use wire thread inserts to prevent the possibility of metal chips entering and clogging the system. Pipe thread inserts have been specified for the tapered pipe thread openings at the inlet and outlet of each aluminum pipe casting. However, it is not intended to develop MIL standards for pipe thread inserts because of the decreasing use of pipe threads in aircraft equipment. Perhaps some other phase of industry that has sufficient need for such standards will develop these.

**The Military Standards for Wire Screw Thread Inserts were developed by the Engine and Propeller Standards Utility Parts Committee (E-25). Helping in the actual work were:**

**D. H. Secord,**
Pratt & Whitney Div., United Aircraft Corp.

**G. M. Garcina,**
Allison Div., General Motors Corp.

**Harkness Cram,**
Heli-Coil Corp.




# Research Group Aims for Answers On Truck-Highway Relationships

**Hoy Stevens,**
Highway Transport Research Branch, Bureau of Public Roads, U. S. Department of Commerce

Excerpts from paper "Economic Research in the Truck-Highway Weight Problem," presented at SAE Annual Meeting, Detroit, January 12, 1954.

THERE's some real hope for a workable compromise future on highway truck weight and size which will foster the most efficient use of the combination of the vehicle and the highway. This hope grows out of a three-part research program undertaken by the Highway Research Board's Committee on Economics of Motor Vehicle Size and Weight.

The three studies are:

1. Truck Operation Costs
2. Highway Operations Costs
3. Commodity Movements and Shipping Densities

## *1. Study of Truck Operation Costs*

In the study of truck operation costs, it is planned to collect data related to several types, sizes, and capacities of highway freight vehicles, ranging from gross weights of not less than 20,000 lb, up to the largest highway transport trailer combination, or truck, that is now in use. The cost data are to include investment, operating, maintenance, and overhead costs of vehicles employed in the transport of freight in line haul, over-the-road service.

The cost data are not to include certain for-hire carrier expenses, such as city pickup and delivery costs, terminal costs, sales expense, claim costs and

revenue billing costs. These items are not affected by size and weight limitations, and these expenses are not encountered by most private carriers operating over-the-road trucking services.

It is planned to develop truck operation costs for several general types of over-the-road trucking services, to learn the effects that different operating practices have on transportation costs per unit of freight. For example, common carriers of general freight strive to have payloads in both directions, whereas carriers of individual commodities, such as steel haulers, coal haulers, loggers, construction haulers, and agriculture exempt carriers normally have payloads in only one direction. Also, the operating practices of private carriers may vary from payloads in one direction only, to payloads all or part time in both directions.

We plan to solicit this detailed information from the several types of carriers, and will need the cooperation of the carriers to get the information from their records.

Operation costs for the various trucking services need to be developed on some unit of freight-transported basis, that can be used with a comparable unit cost basis that can be developed for the highways. It appears likely that this may be a ton-mile unit of freight-transported, but it also is possible that a more significant measure of service, which will apply to both the vehicles and the highways, may come out of the research.

## 2. Study of Highway Operation Costs

The second research study is to establish highway costs including those of original investment, construction, and maintenance. This study has many interlocking variables, necessitating determination of costs for several levels of highway design to accommodate different levels of maximum weights, frequencies of commercial vehicles, and the intensity of the general traffic. The variables include: design capacities of pavements and bridges, types of pavements, effects of different axle arrangements and weights of vehicle upon pavements and bridges, reductions in grades, truck lanes on grades, alignment for sight distance, number of traffic lanes, undivided versus divided highways, frequency of heavy vehicles in general traffic, intensity of all traffic, traffic controls methods, right-of-way widths, width of paved shoulders, width of drainage aprons, survey costs, maintenance costs, and other elements of a highway system.

To develop a series of highway costs related to various vehicle maximum weights, the following steps appear necessary:

1. Assume a series of maximum size and weight specifications for practical highway freight vehicles. Assumptions should go as far above present maximum allowances, as appears foreseeable in the present state of the art of designing and manufacturing highway freight vehicles.

2. Establish a series of levels of highway designs with each level designed to carry some assumed frequencies of maximum weight vehicles and other traffic. The maximum weights of the heaviest vehicles in each level of highway design should conform to one of the maximum weight specifications established in step 1.

3. Determine the costs of providing highway facilities for the several different levels of highway designs which are established in step 2.

The sources of the highway cost data will be research studies such as are being made by various State highway departments and the Bureau of Public Roads. Information is being obtained on costs, maintenance costs, road condition, and traffic on sections of highways. Along with these data, there is being obtained the number of freight vehicles and their gross weights. The vehicle data may be either the comprehensive records that can be obtained at permanent truck scale installations, or may be sample weight data obtained periodically by loadometer studies by state highway departments.

In this manner, there can be developed a series of highway cost values which can be arranged in a family of trend curves to show highway costs and the variations that result from changes in the size, weight, and frequency of heavy vehicles in general traffic.

To develop the cost differentials resulting from increases in the maximum weights of vehicles, it likely will be necessary to develop and agree upon costs for basic pavements and bridges capable of carrying general traffic and trucks of gross weights less than some agreed ceiling, say 20,000 lb gross, as an example. The costs of basic highways should include, in addition to the costs of the limited capacity pavements and bridges, all other costs that do not vary with increases in maximum size and weight of commercial vehicles, and a proper proportion of the costs that do vary with size and weight.

It is likely that there will be more than one such basic highway because the number of traffic lanes, traffic control devices, width of right-of-way, and similar items are dependent to a considerable extent upon the total volume of general traffic.

The cost differential between the basic highway and the highway for each different level of maximum vehicle weight and vehicle frequency would represent the increased cost attributable to providing the different level of increased weight carrying capacity. Such cost differentials then can be reduced to some unit of freight-transported costs, and be plotted to show the trends of highway unit costs as vehicle weights and frequencies are increased.

It is obvious, that historical highway cost data may have to be extrapolated to any new specifications of vehicle maximum weights and traffic intensity which may be assumed or be indicated by other phases of the research. It is partially to supply guiding information as to how to predict cost data for highways of greater load capacity, that there is a need for comprehensive road and load data on the order of that which can be obtained from accelerated road tests.

## 3. Study of Commodity Movements and Shipping Densities

In the third part of the research we plan to assemble a variety of data regarding commodities[1] which might be transported by highway. These data are to include:

a) The shipping densities[2] of commodities,

b) The maximum payloads when the various commodites are loaded so as to visibly fill the cargo spaces of various highway freight vehicles,

c) Estimated total tonnages of the various commodities that might be transported by highway,

d) Estimated ton-miles of transportation for the commodities which might be transported by highway.

Our purposes in collecting such data are to explore simultantously with the truck cost and highway cost studies, any commodity factors, either economic or otherwise, which may have a bearing on the problem of establishing optima of truck-highway size and weight specifications for the future.

[1] The term "commodity," as used in this discussion, includes all materials and articles of commerce that are shipped by any medium of transportation.

[2] The term "shipping density" means the average weight of an average cubic foot of a commodity, when it is packaged for shipment. In the case of materials handled in bulk the term refers to the average weight per cubic foot of a bulk material when in the condition which it is in when loaded on the transport vehicle.

## 4. Putting the Data to Work

When collection of the basic data is completed, we expect to have, amongst other data, three families of trend curves, the commodity density and shipping volume charts on the order of Fig. 1, and curves showing trucking and highway unit costs. The two hypothetical trucking and highway cost trends charts have been generalized and combined on one chart, for purposes of illustration, in Fig. 2.

As this chart indicates, I think we are more likely to get curves which may have rather long relatively flat sections. Thus the sum of the combination of vehicle costs and highway costs may have a relatively long range of weights wherein there is little change in total cost per unit of freight transported. Of course, even if the curves do not have such flat sections, the relative changes in the sums of the two costs in an area of the chart may be so small that there will exist a range of maximum vehicle weights in which there may be no significant reductions in combined truck and highway costs as the axle and gross vehicle weights are increased.

If such a situation develops, the question will arise as to the justification for greater investment in greater load carrying capacity of highways, when there would result no further gains in total transportation costs for the total amount of freight hauled over a highway. However, until the truck cost data and the highway cost data are established, we can only speculate on the trends.

After this over-all organization of the data, it will become the job of a much larger group than the Committee on Economics of Motor Vehicle Size and Weight to resolve an acceptable compromise for future truck-highway size and weight specifications that can be used in highway planning. This larger group also will have to weigh the present large investment of public money in highways, and the costs of rebuilding, extending or up grading the highway system to any higher load capacity standard, if a higher standard is indicated.

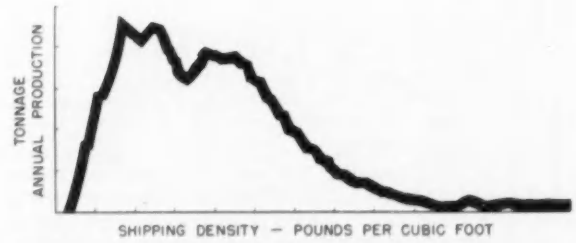



Fig. 1—It is hoped to be able to chart data of this kind after the Committee on Economics of Motor Vehicle Size and Weight completes its work

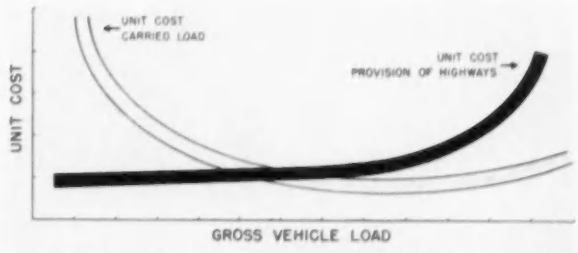



Fig. 2—Economic balance of highway transportation from comparison of trucking and highway costs is another result hoped for from current researches

**Supersonic aircraft skins must be light, yet able to maintain strength at extreme temperatures. The answer may be . . .**

# All-Metal Honeycomb

ALL-METAL honeycomb sandwich structures are designed to withstand the high stresses and temperatures encountered in supersonic flight. Their unique properties permit many applications, both inside and outside the aircraft.

Basically, a honeycomb structure, as shown in Fig. 1, is an anisotropic, integrated sheet metal assembly. Foil-thin ribbons, joined in honeycomb pattern, comprise the core; which is securely sandwiched between metal facings or skins. The core provides continuous support to the facings to prevent buckling under compression. At the same time it transmits shear stresses.

The honeycomb sandwich has extraordinarily high strength-to-weight ratio, excellent stiffness, good thermal and acoustical insulation properties, excellent fatigue resistance, and high dampening ability. Of course, these properties depend upon the materials used in the structure.

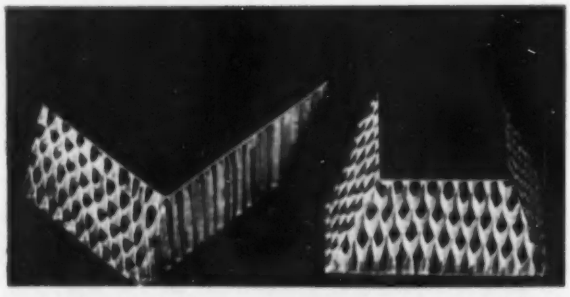


Fig. 1—The all-metal honeycomb structure is composed of foil-thin ribbons, joined in honeycomb pattern, which are securely sandwiched between metal facings or skins

## Sandwich is Made of Steel Alloy

All-metal honeycomb sandwiches are usually made of steel alloys because of their ability to maintain strength at temperatures up to 1500 F.

Aluminum alloys and other light metals have the necessary strength-to-weight ratios at room temperatures, but at high temperatures their strength properties fall off rapidly. Titanium shows promise for uses up to 800 or 900 F, but much development and testing still must be done.

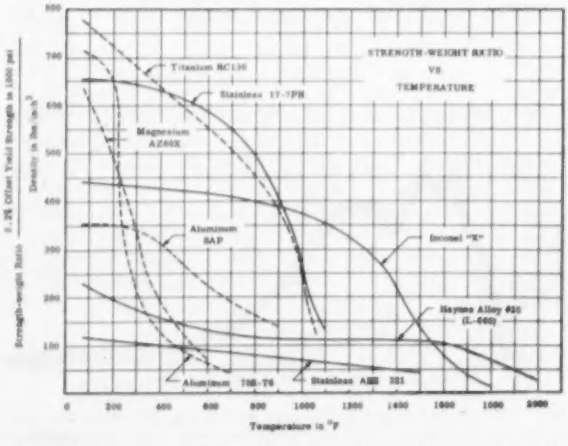



Fig. 2—Crashing through the thermal barrier requires metals which keep their strength at high temperatures. This is a comparison of alloys currently being used

# Sandwich Structures

J. V. Long and G. D. Cremer, Solar Aircraft Co.

Based on paper "High Temperature All-metal Sandwich Structures," presented at SAE Los Angeles Aeronautic Meeting, Oct. 7, 1954. Paper is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.

Some of the high-temperature, corrosion-resistant metals which have been used for sandwich structures include SAE 30321, Armco 17-7PH, Inconel X, Multimet, and Haynes Alloy 25 (L-605). Fig. 2 shows comparative curves for a number of alloys, plotted yield strength per unit weight versus temperature. Below about 900 F, the superiority of 17-7 stainless steel is evident. Higher temperatures require Inconel X or L-605.

## Core Design Varies With Use

Steel and high alloy sandwich core consists of thin ribbons of metal 0.001 to 0.010 in., joined together to form a honeycomb structure with square, hexagonal, oval, or specially shaped cells. The ribbons are made into cells by resistance welding or adhesive bonding at the nodes. Other methods include wire stitching, eyeletting, and slotting. Fig. 3 shows the "squarecell" type. Some cores are flexible and can be bent to allow curved sandwich applications. Fig. 4 shows a finely corrugated core assembled in "squarecell" fashion, a "multiwave" core which is stabilized by longitudinal ribbons and a wegcell core. The "sinecell" core, shown in Fig. 5 is flexible in three dimensions.

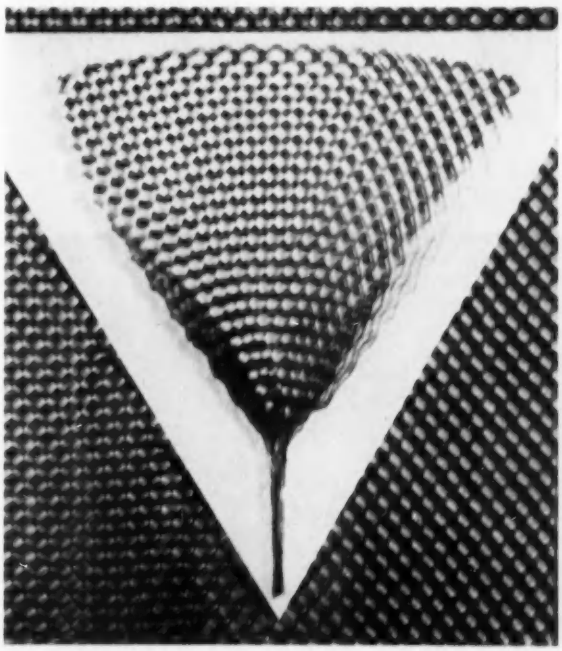


Fig. 3—The squarecell core can be collapsed if grinding or machining is required

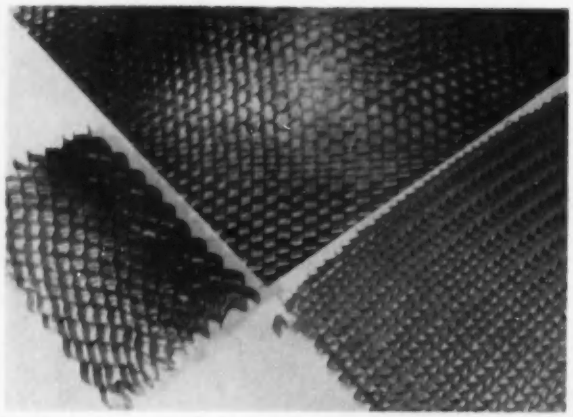


Fig. 4—Three types of cell design: (left) finely corrugated squarecell; (center) wegcell; (right) multiwave

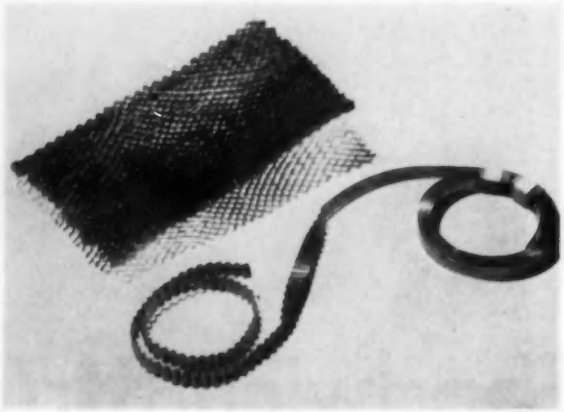


Fig. 5—Sinecell core is flexible to some degree in three dimensions

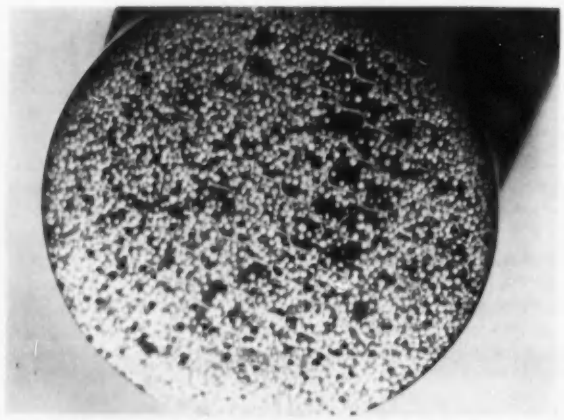


Fig. 6—This is a macrophotograph of a sinecell core structure. Steel shot can be used for edge support

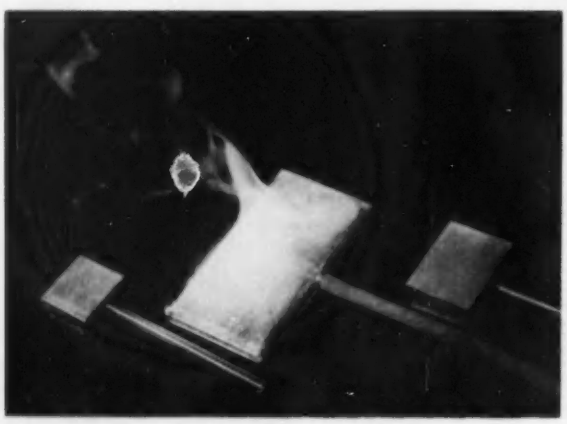


Fig. 7—This sandwich structure has permeable facing which allows smoke or water vapor to be blown through it

## Core is Brazed to Facing

The core is welded or brazed to the surface skin, which is usually between 0.010 and 0.030 in. thick. Brazing is better than welding because it assures a continuous, high strength, metallurgical joint. Due to the formation of fillets between mating surfaces, there is greater bond area and uniform stress distribution. So, the skin spanning each cell is further stiffened. And, the brazing alloy infiltrates the node laps and improves their column and shear properties. A typical brazed core is shown in Fig. 6. This is a macrophotograph showing well bonded node areas in ⅛ in. sinecell core structure. Steel shot has been used for edge support.

A sandwich structure is no stronger than the bond between its parts. So the brazing must be strong and long lasting. Since brazing temperatures are around 1900 F, there is unlikely to be a failure at the temperatures encountered during supersonic flight. Tests up to 1650 F show that brazed sandwich material has better creep resistance than adhesive bonded sandwich.

The strength of the sandwich structure also depends upon cell design. Through proper choice of cell shape and material it's possible to get compressive strengths as high as 4000 psi in 2 mil-¼ in. cell core. This strength enables sandwich structure to be used for many different applications.

## Sandwich Has Many Uses

All-metal sandwich structures are still in the development stage, but several applications have already been proved successful.

**Afterburner shroud**—A stand-off, self-supporting afterburner shroud made of high temperature honeycomb sandwich, was developed to cover a tailpipe that ran above 2000 F. Both insulation and reflective heat barrier properties were desired in a

strong, light weight, fatigue resistant structure. It has proved successful in flight tests under severe conditions. Other similar uses for sandwich structure, where thermal barriers are required, are fire walls, ducts, blast cowls, and fuel tanks.

**Porous skin sandwich**—If one or both surfaces of the sandwich are made of perforated or permeable metal, fluid will be able to flow through the skin. Fig. 7 shows a sandwich panel which permits vapor to pass through it easily. This is particularly useful for sweat cooling or heating purposes. Possible aircraft uses for porous faced sandwich includes anticing, aerodynamic bleed, and boundary layer control.

**Fluid cooled sandwich**—The aircraft industry has made considerable use of marcel or corrugated sandwich core for heat exchangers, in such items as anticing leading edges, air cooled turbine blades, and heated inlet guide vanes. All metal honeycomb gives the necessary fluid flow with greater outer surface support. Fig. 8 shows two modified "sinecell" honeycomb cores, with cotton threads marking several of the many fluid channels. In one case flow is longitudinal as a result of milling slots on both sides of the core; the other has passages through each cell formed by alternately spot welding the nodes at the top and bottom.

**Rotary pressure seals**—There is a possibility of using all-metal honeycomb for rotary pressure seals. An openfaced sandwich would function as the stationary seal while a precision knife-edged disc or disc labyrinth would comprise the rotating seal member. The relative expansion and other mismatching between the disc and the openfaced sandwich core would be accommodated by the rotating member cutting into the stationary core, thus making a self-matching unit.

**Shaped sandwich**—Many uses for contoured sandwich structures, as shown in Fig. 9, are possible. Leading edges, fins, control surfaces, slats, and turbine vanes are a few.

**Conical structures**—Conically shaped parts are frequently used in missile and aircraft construction. All-metal sandwich can be used for inlet air diffusers, ducting tailpipe shrouds, fuselage or engine nacelles, and missile nose sections. Fig. 10 shows several nose cones fabricated by high temperature brazing.

**Blast panel**—A composite, all-metal sandwich can be used as a rocket blast shield. This shield has a normal structural sandwich base, upon which a refractory filled honeycomb core and face sheet is superimposed. The refractory core resists extremely high velocity, high temperature exhaust gases for brief periods of time.

So it seems, all-metal sandwich structures may find a broad application in the aircraft industry, particularly in high Mach aircraft and missiles.

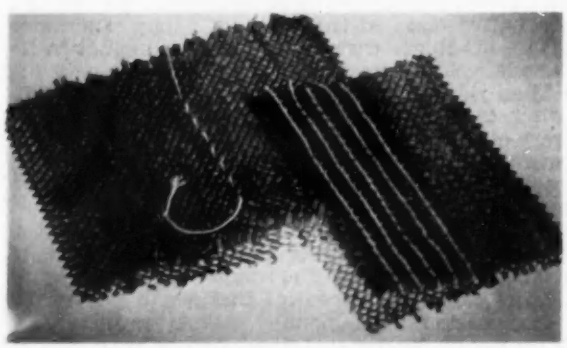


Fig. 8—Sinecell honeycomb cores can be modified to allow fluid flow channels as marked by the threads

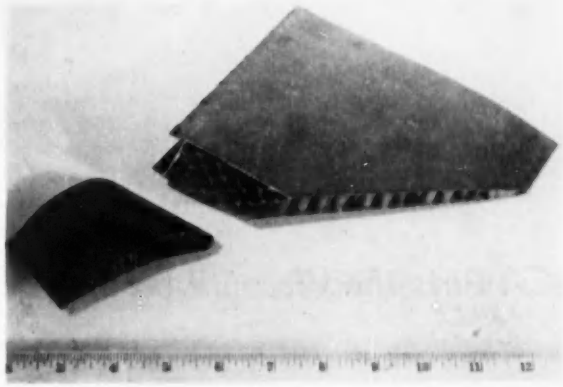


Fig. 9—Contoured sandwich like this can be used for fins, control surfaces, turbine vanes, and leading edges

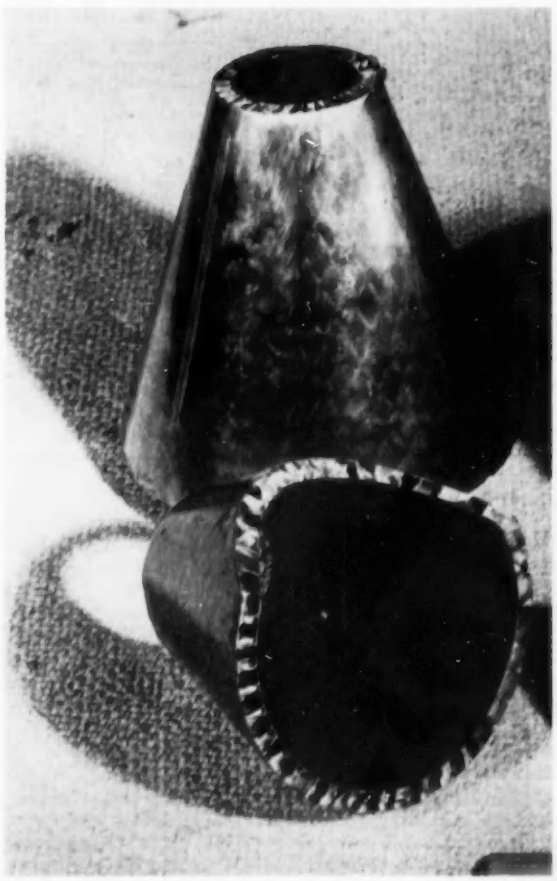


Fig. 10—Conical shaped parts such as these nose cones, which were fabricated by high temperature brazing, have many uses on missiles and aircraft

# TCA Views the Turbine

## *TCA Puts the Viscount on Intercity Routes Now*

**G. R. McGregor,** President, Trans-Canada Air Lines

Based on paper "Trans-Canada and the Vickers Viscount" presented at the SAE Metropolitan Section meeting, New York, Nov. 4, 1954.

TRANS-CANADA Air Lines has chosen the Vickers turboprop-powered Viscount to satisfy its immediate need for fleet expansion for intercity routes. The Viscount beat out its closest competitor in the end because it had four engines instead of two and because its turboprops had more passenger appeal. We made our choice several years ago and are now about to put Viscounts into operation.

The need for additional planes became apparent back in 1951. Operational studies soon narrowed the field down to two possibilities: the Viscount and a well-known U. S.-built twin-piston-engine transport.

Management knew that there would be something better than either the turboprop or the piston-engine contender if TCA could wait for it. There always is. We did not relish the prospect of being the guinea pig for a new aircraft type. Neither did we want to come into the turbine field at the tail end of the airline procession.

Consideration turned to intangibles. The piston transport carried U. S. gadgetry that we knew and trusted. Also geographical proximity promised close liaison during manufacture and reasonably sure availability of parts thereafter.

On the other hand, the British candidate featured Dart turboprop engines by Rolls-Royce. We had had nearly five years, at that time, of happy experience with Rolls-Royce through the Merlin engines in its Canadair North Stars.

Then we found that Vickers was quite willing to switch to American gadgetry—and make just about every other modification TCA had to suggest. This meant a completely new cockpit, redesigned fuel system, and completely new cabin interior including heating and pressurization.

This evened the score between the two planes. Final decision in favor of the Viscount was made primarily on the basis of (1) four-engine safety and (2) the passenger appeal of turbines.

Engines do fail occasionally. When that happens, it's better to lose one of four engines than one of

Continued on page 58

**TCA's Viscounts**

| | |
|---|---|
| Wing span | 93 ft 8 in. |
| Overall length | 81 ft 2 in. |
| Passenger capacity | 40 seats |
| Cruise speed | 315 mph |
| Cruise altitude | 15,000–22,000 ft |
| Block speed over 600-mile stage | 275 mph |
| Gross take-off weight | 60,000 lb |
| Landing weight | 54,000 lb |
| Zero-fuel weight | 49,000 lb |
| Operational empty weight (including crew) | 38,000 lb |
| Average payload | 11,000 lb |
| Engines | 4 Dart turboprops |
| Rated power | 1400 hp per engine |
| TCA overhaul interval | 750 hr |

# Era

## *For Longer-Range Transports, TCA Will Wait Till 1960 for Turbines*

**J. T. Dyment,** Director of Engineering, Trans-Canada Air Lines

Based on paper "An Airline's Viewpoint of the Status of the Turbine Era" presented at SAE Golden Anniversary Annual Meeting, Detroit, Jan. 10, 1955.

FOR transcontinental and transoceanic use, we believe most airlines—including Trans-Canada Air Lines—will wait five more years before initiating turbine transports. By then there will be a selection of turboprop, turbojet, and possibly bypass-engine transports available.

Most airlines will not buy jets until they can operate them economically and with as much flexibility as they do current transports. Of course, some government-controlled airlines must use certain equipment as a matter of national policy to keep certain manufacturers in business. These airlines can be subsidized to use a high-performance but uneconomic aircraft, thus forcing competitors to do the same. But TCA, although government owned, is not under any such compulsion. We are free to choose the airplane we feel will best do the job and do it economically.

Here is our prediction of the turbine timetable:

*Engines*

1957–1958—The Rolls-Royce Dart RDa7 rating will rise to 2000 shaft hp.

1958–1959—The two-spool Rolls-Royce RB109 turboprop will become available. Fuel consumption is only around 0.4 lb per eshp-hr. Power rating is 4400 eshp for take-off. Weight is 1850 lb. ("Eshp" is "equivalent shaft horsepower.")

1959–1960—The Bristol B.E. 25 two-spool turboprop will become available. Fuel consumption is close to 0.4 lb per eshp-hr at 350 knots at 36,000 ft. This engine, derated from a military version, can provide 4000 shp or 5050 eshp for take-off up to an altitude of 5000 ft. The engine weighs around 3000 lb.

1960—The Rolls-Royce Conway bypass engine will be ready to compete. Fuel consumption, we can guess, will be down around 0.7 lb per lb thrust-hr.

*Airplanes*

1957–1958—The Vickers Viscount will prove so popular that Convair will bring out a turbine version of the Convair 340. The turboprops may be British, unless Convair can soon solve current problems with available American turboprops.

1957–1958—The Bristol Brittania will enter the transoceanic and transcontinental field. Perhaps the company can Americanize the Brittania enough through its affiliation with Canadair to appeal to operators on this side of the Atlantic.

1957–1958—The Lockheed 1449 turboprop Super Constellation should become available.

1959–1960—Douglas will have its turboprop transport ready for transcontinental and transoceanic service.

**Please Turn Page**

1959–1960—Vickers will have a turboprop transport for mainline transcontinental service.

1960 —The Boeing 707's turbojet descendants will be ready for transoceanic service, if airlines settle soon on what they would want in it.

1960 —The Vickers 1003 bypass-engine transport should be ready. (The 1003 is a descendant of the Valiant bomber and of the V1000 troop transport.)

1961–1962—Douglas and Lockheed could have an excellent turbojet ready.

None of these aircraft is a DC-3 replacement. Perhaps there will be one by 1960. But we are more confident that there will be these larger turbine-powered craft in operation by 1960 than we are that there will be a new plane for short-haul service.

Eventually there will be a DC-3 replacement, perhaps a turbine-powered helicopter. There will be turboprop planes for the medium hauls with stops 300 to 800 miles apart . . . and bypass engines to power planes for the 2000–3500-mile transoceanic flights. For the heavily traveled mainline transcontinental flights with stops 400 to 2000 miles apart, we expect that all three types of turbine engine—the turboprop, the bypass engine, and the turbojet—will be in action.

The powerplants for medium hauls will be in the 2000 hp class. Those for transcontinental service will rate around 5000 hp and those for transoceanic service around 8000 hp—or 10,000 and 15,000 lb thrust, respectively, in the case of pure jets. Operators will want four engines in all classes of transports except "puddle jumpers." Therefore it will no longer be practical to use the same engine in medium-size and large-size transports, merely by using two engines in one class and four in the other.

Before turbine engines come into operation there are four improvements we earnestly hope will be made:

1. Variable exit nozzle to make the engine more economical to operate over a wider range of conditions.

2. Fully automatic fuel-flow control, requiring a minimum of attention from the pilot.

3. Reverse thrust for minimizing landing distances.

4. Reduction in noise level.

In the turbojet, we'll want reduction in fuel consumption, also.

Besides these improvements in the engine, we'll want the airframe manufacturers to give us:

1. Simplified cockpit controls.

2. Lower approach speeds.

3. Provision for speedier ground handling.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

## *TCA Puts the Viscount on Intercity Routes Now . . .*

. . . continued from page 56

two engines. True, it has been argued that four engines are twice as likely to fail as two. But happily, experience does not support the argument. (Unhappily, experience does show that four engines can't be so cheaply maintained as two of equivalent total power.)

The passenger appeal of the turboprop lies in its newness and its relative cabin quietness and freedom from vibration.

These two points, then, caused TCA to pick the turboprop Viscount over the piston-engine contender. Absolutely no considerations of national background, trade balances, or any other factor not directly connected with the airline's equipment needs entered into the decision.

Two and a half years have elapsed since the decision to buy Viscounts. We thought it was the right decision then. Now we are sure of it. Two major airlines have operated the Viscount in Europe for several years. Passengers are enthusiastic. Engine ratings have climbed steadily since British European Airways premiered the plane on its London-Paris run in July, 1950. Overhaul intervals have stretched. The airplane has more than fulfilled its design promise.

TCA originally estimated direct operating costs at 2¢ per seat mile. The already achieved increases in overhaul interval ought to lessen the figure. Fuel consumption is high by piston-engine standards. But fuel cost per gallon of the JP-4 TCA will use is low. The result is that fuel cost per horsepower for the turboprop is almost identical with that of the piston engine burning high-octane aviation fuel.

One last advantage of the Viscount—an advantage particularly important to a Canadian operator—is that its turboprops are better suited to cold-weather operation than any piston engine. The turboprop has only its three main bearings in moving contact. Thawing the lubricant is much less of a problem than with the piston engine.

Vickers flew the Viscount to Canada for cold-weather tests in February, 1953, the first turboprop-powered crossing of the Atlantic. The most severe conditions Canada could produce right then were a – 27 F temperature with a 25-knot wind, at Churchill. Pilots, crew, and technical staff suffered—but the Viscount did not.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

# Thin high-speed PROPS must withstand high stresses

**F. B. Stulen,**
Propeller Division, Curtiss-Wright Corp.

Based on paper "The Structural Design of High-Speed Propellers," presented at SAE Los Angeles Aeronautic Meeting, Oct. 9, 1954. This paper will be published in full in the 1955 SAE Transactions.

CONTRARY to previous beliefs, good propeller efficiency can be had at high subsonic and transonic speeds if the blades are designed with low thickness-ratios. And at supersonic speeds, satisfactory efficiency is possible if the entire blade length has a very thin profile. But these thin propeller designs must be able to withstand the stresses which they meet in service.

Since high-speed propeller-driven airplanes will be powered by turbine powerplants it is fortunate that the turboprop installation develops only a few types of stress vibrations. One type is the first ordered aerodynamically excited vibration; another is subsonic stall flutter. These vibrations may be accurately predicted and controlled by proper design. But aerodynamic and structural requirements are not always compatible. Propeller design must be a compromise between the two for best efficiency.

## Propellers Must Be Efficient At All Speeds

Aerodynamically, a propeller usually requires:

(a) high propulsive efficiency for cruising,
(b) high take-off and climb thrust,
(c) satisfactory efficiency at maximum speed.

Best efficiency at cruising or top speed occurs when the sections of the outer part of the propeller blade are operating at blade angles near 45 deg and are loaded to a point near the maximum lift-drag ratios of these tip sections. However, the blade sections in the inner third of the blade length are set at section angles near 90 deg, so that the drags of these stations are opposite to the direction of flight. They directly decrease the total thrust of the propeller.

To counteract this drag loss, the power supplied to the propeller must be greater than that necessary for the peak efficiency of the outboard sections. That is, the peak efficiency of a prop corresponds to a load slightly higher than that required for the maximum $L/D$ of the outboard sections. This overload permits smaller diameter propellers and weights.

The efficiency of any blade element may be calculated by the formula:

$$\eta = \frac{L/D_T - J/\pi x}{L/D_T + \pi x/J}$$

where:

$\eta$ = section efficiency
$J$ = the distance that the propeller moves forward in one revolution with propeller diameter as a unit of measure
$x$ = proportional blade radius = $\dfrac{\text{section radius}}{\text{tip radius}}$
$L/D_T$ = the ratio of lift to the total drag of the section blade profile

In subsonic propellers, the total drag is the sum of the section profile drag and the induced drag (similar to the induced drag of wings).

Reasonably good efficiencies are obtained in the outboard or working portion of a blade if the lift-drag ratio exceeds 8 or 10, and if the advance ratio is not too low or too high. As shown in Fig. 1, peak efficiencies of the outboard profiles occur near an advance ratio of about 2.0.

Efficiencies of inboard blade elements are generally not high since these elements must be op-

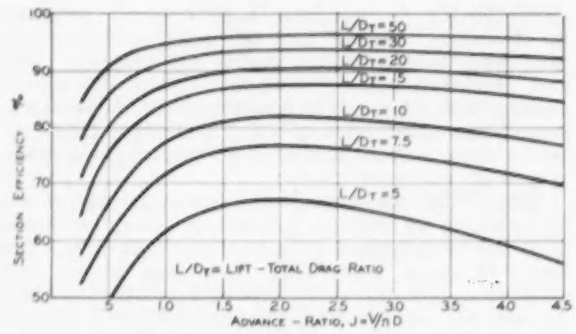



Fig. 1—This shows the efficiency of the section at 75% of propeller radius as a function of advance-ratio and lift-drag ratio. Peak efficiencies occur near an advance ratio of about 2.0

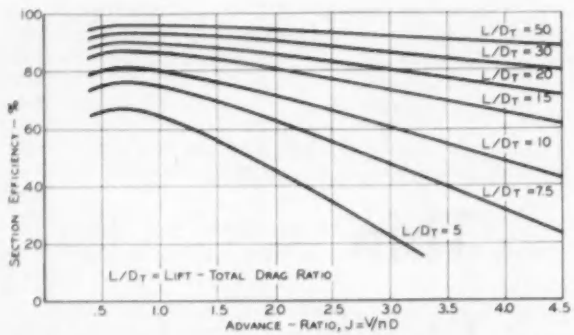



Fig. 2—This shows the efficiency of the 25% radius section. When the lift-drag ratios are less than about 15, efficiencies drop rapidly

erated at excessive blade angles. As shown in Fig. 2, efficiencies drop rapidly when the lift-drag ratios are less than about 15/1. For this reason propellers should be designed to absorb a minimum amount of power in the inner portions of the propeller.

From Fig. 3 we see that lift-drag ratios higher than 10 are possible at supersonic speeds, if the thickness ratios of the profiles are not greater than 3%.

## Power Capacity Depends on Total Solidity

The amount of power a propeller can absorb depends on the *total solidity* at the 70% radius and not the solidity of one blade. (Total solidity is the chord of the blade at the 70% radius, multiplied by the number of blades, divided by the propeller diameter.) For example, a propeller of eight blades has roughly the same power capacity as a propeller of four blades with double the size chords.

The number of blades which a propeller should have for best efficiency depends on several factors. In subsonic propellers, the momentum loss in the slipstream decreases as the number of blades is increased. The total profile drag remains unchanged if blades having profiles of equal thickness ratios are used. But if the inboard sections remain the same size, and only the outboard chord profiles are changed, then there is usually a loss in efficiency as the number of blades is increased.

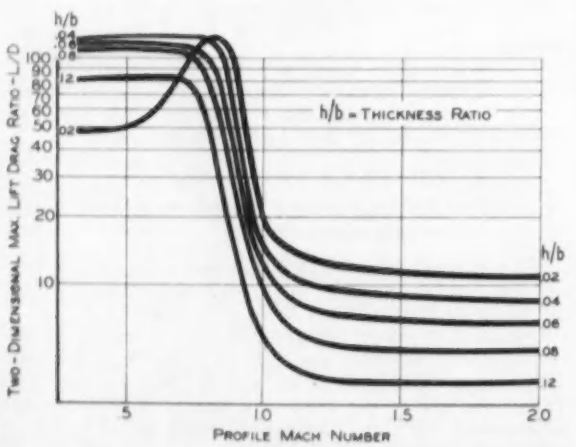



Fig. 3—This illustrates the two-dimensional maximum lift-drag ratios for NACA-16 series profiles having optimum design and operating lift coefficients

## Propeller Diameters Will Remain the Same

The diameter of a propeller can be decreased if its total solidity is increased. But the required solidity increases rapidly as the diameter is decreased. And the induced or momentum loses increase. So, the practical amount of diameter reduction is limited.

As airplane speeds increase, the propeller diameter needed to absorb a given power will decrease. But this will be offset because large increases in power are needed for transonic and supersonic speeds. So, there will probably be no significant change in the diameters of current propellers. Also, at transonic forward speeds the diameter affects the momentum loss in the slipstream less than at subsonic speeds. At supersonic speeds one or more of the following ways of absorbing the large power are available:

(a) increasing the solidity by increasing blade chords,

(b) increasing the number of blades by single-rotation tandem units,

(c) increasing tip speed,

(d) loading the propeller as high as possible without sacrificing efficiency too much.

Propellers of conventional diameters (13 to 15 ft) having eight or more blades arranged in two rows of four each can absorb very large amounts of power at high speed if the section thickness-ratios are low enough along the blade radius.

We've seen that the propeller diameter and solidity for best efficiency at cruising or top speed are selected so that the operating lift coefficient results in the highest ratio of lift to total drag. Also, so that the advance ratio is in the proper range. In many cases, however, the demand for high static thrust requires larger propeller sizes. Thus, the propeller is underloaded at high speeds. If this

compromise is too great in favor of the static thrust, large losses in high-speed efficiency may occur.

## Centrifugal Loads and Stresses Vary With Speed

Centrifugal loads and stresses vary directly with the square of the propeller's rotational speed. So, the rotational speed must be kept as low as possible. This is equivalent to operating the propeller at as high an advance ratio as practical. Increasing the advance ratio will greatly reduce the centrifugal loads in the propeller. Referring to Fig. 1, an increase of the advance ratio from 2.0 to 3.0 reduces efficiency only about 1.2% for an $L/D$ value of 10. The centrifugal stresses and loads are reduced to 44% of their former values. This loss in efficiency can be regained by redesigning the sections to lower thickness ratios, thereby reducing the propeller weight.

In solid blades designed for high transonic and supersonic speeds, the blade weight and centrifugal force are proportional to the square of the blade chords. Also, the centrifugal twisting moment of the blades varies as the fourth power of the chords. Thus, for very high horsepower, propellers may consist of a relatively large number of blades having narrow chords, probably arranged in tandem fashion.

## Maximum Forward Speed of Propellers

The maximum forward speeds which are possible by propeller-driven airplanes may be estimated from the advance ratio and the centrifugal stress. This stress depends upon the mass distribution along the blade, the density of the blade material, and the square of the tip speed. The maximum centrifugal stress of practical hollow or solid steel blades is between 25,000 and 40,000 psi when the rotational component of the tip speed is 1000 fps.

At supersonic speeds, extremely high temperatures affect the strength of the blade materials and limit the speed. Temperatures estimated for various Mach numbers are shown in Fig. 4. The maximum Mach number for propellers made of currently used metals appears to be between 2.5 to 3.5.

## First-Ordered Vibration of Propellers

A disturbance in the air stream entering the propeller disc can excite high vibratory stresses in the blades. If it occurs at a frequency equal to the rotational speed of the propeller it's designated as the first ordered or "one times the propeller speed" ($1 \times P$) vibration. These disturbances may be due to the proximity of the fuselage, wing, and nacelle, by induced effects of adjacent propellers, or by the actual pitch and yaw of the airplane.

Present-day blades with thin sections and higher activity factors are highly sensitive to the $1 \times P$ excitation. The $1 \times P$ vibration is caused by periodic lift forces on the blades induced by an oscillating change in their angles of attack when the propeller shaft is inclined to the direction of flight.

In one complete revolution of the propeller, each blade section is subjected to an increase and decrease in lift force, maximum and minimum values occurring at the horizontal blade positions. (In the vertical positions there is no significant change in average lift.) This cyclical change in blade lift induces a bending vibration with a frequency exactly equal to propeller rotational speed.

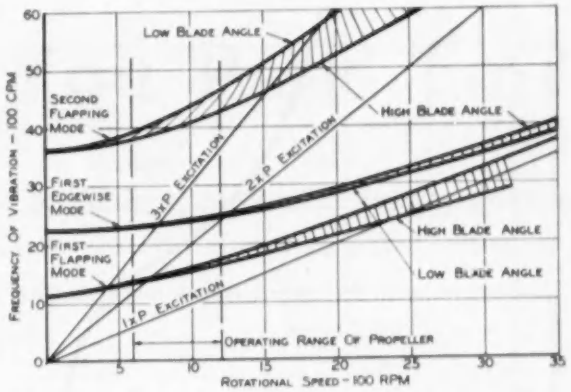



Fig. 5—This is a frequency diagram for a conventional subsonic or transonic propeller blade. The first-order ($1 \times P$) excitation frequency line intersects the fundamental natural frequency curve at relatively high rotational speeds and high blade angle settings. The turbulent condition of cross-wind causes an excitation at a frequency equal to twice the propeller speed ($2 \times P$)

A propeller blade is similar to a twisted, tapered cantilever beam subjected to alternating lateral inertia forces as well as centrifugal and aerodynamic forces. The alternating aerodynamic and inertial forces displace the propeller blade sections from the plane of rotation, whereas the centrifugal force and blade stiffness tend to return the blade sections to the plane of rotation.

As the rotational speed of the propeller is increased there is additional stiffness of the blades due to the restoring action of the centrifugal forces. Hence, the natural frequencies of the blades continually increase with increased speeds. A frequency diagram for a conventional propeller design which illustrates the variation of the natural frequencies of the first three modes of vibration with rotational speed and blade angle is given in Fig. 5.

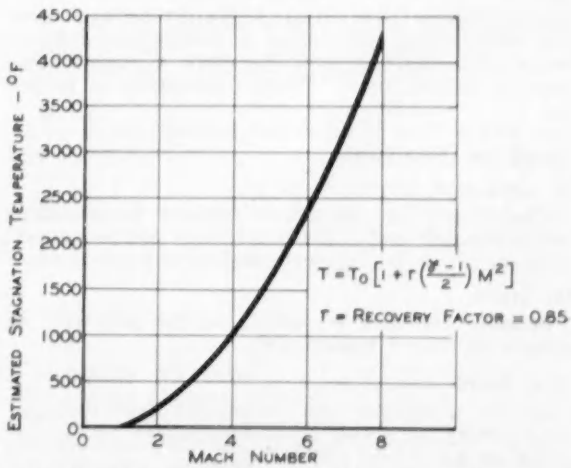



Fig. 4—Stagnation temperatures for supersonic speeds are shown above. Since the strength of currently used materials decrease rapidly for temperatures exceeding 300 to 800 F the maximum forward Mach number of propellers appears to be in the range of 2.5 to 3.5

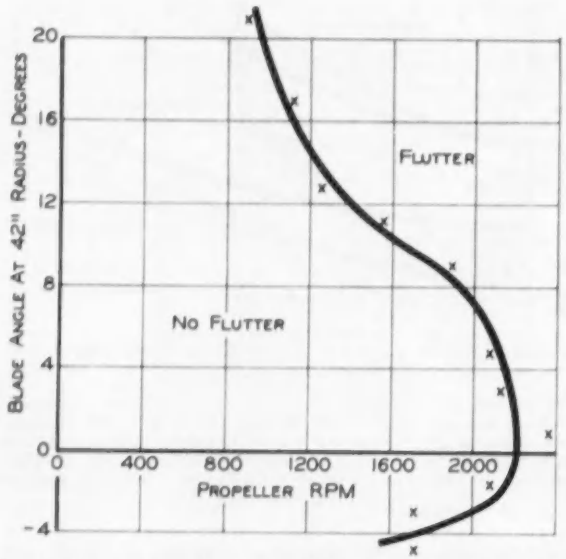



Fig. 6—This is an example of a closed type flutter boundary. If the blade is exceptionally thin it will twist up to the stall point when a high rpm is reached regardless of initial blade angle setting

## Normal Forces and Moments Affect Lateral Stability

The same oscillating lift forces acting on the blade elements which cause the 1 × P vibration also create a force perpendicular to the propeller shaft and a bending moment on the shaft. This "normal" force and moment are essentially constant with respect to time if there are more than two blades in the propeller. They affect the lateral stability of the airplane, particularly at high speed. They are also important in the structural designs of the propeller shaft, the gear reduction housing, the engine mounts, and the nacelle.

If the axis of a propeller is pitched up in relation to flight direction, the downswinging blade has a greater-than-average tangential velocity with respect to the air. Therefore, it has a greater-than-average torque force (in the plane of rotation). But the upswinging blade has a lower-than-average tangential airspeed and therefore a lower-than-average torque force. These increments of torque force are in the same direction and are additive to cause a net lift force on the propeller shaft.

There are corresponding oscillating changes in the thrust forces of the individual blades. The downswinging blade generates a correspondingly higher-than-average thrusts, while the upswinging blade generates a lower-than-average thrust. This increment in thrust on one blade and the decrement on the opposite horizontal blade create a net bending moment on the propeller shaft. However, there is no significant change in the total thrust or power of the propeller.

## Subsonic Stall Flutter

A type of vibration which influences the design of high-speed propellers is subsonic stall flutter. This type of flutter is simply the resonance of the fundamental natural torsional mode of the blades and is not the "classical" flutter encountered in aircraft wings. The vibration occurs when the outer blade airfoil sections are operating at angles-of-attack near their stall angles. It usually occurs at the static take-off, and during the early take-off run when the propeller is not heavily loaded. No subsonic stall flutter is encountered at any angle of attack if the torsional frequency is sufficiently high.

If the blade is very thin it will twist up to the stall point under the applied steady aerodynamic and centrifugal loads when a sufficiently high rpm is reached regardless of the initial blade angle setting. The static boundary at such a condition is called a "closed boundary" and is caused by torsional divergence. Fig. 6 illustrates the condition of a closed boundary which was discovered several years ago in an experimental supersonic propeller having steel blades with wedge airfoil sections which were only 1½% thick at, and near, the tip. Such a propeller cannot be operated at the static condition except at very low rpms.

As a result of the continued development in the engineering science of propeller design, it is now possible to predict the structural behavior of designs for installation on modern powerplants with greater precision than was formerly possible. (Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

## Based on Discussion . . .

**W. Littlewood,** American Airlines, Inc.

The charts and equations indicate a calculable Mach number and a diameter limit for propellers. Is there also a horsepower limit?

**Mr. Stulen**

Solidity can still be added to the propeller to absorb increased horsepower.

**M. G. Beard,** American Airlines, Inc.

Airline experience has found that more material is necessary for an adequate service life, because of propeller nicks and abrasions.

**Mr. Stulen**

Aerodynamic vibratory stresses exist in only the inboard 10 or so inches of the propeller blade. They are not present in the outboard section of the blade where nicks and abrasions commonly occur. The paper presented had discussed only turboprop installations in which engine induced vibrations in the propeller are entirely absent.

**R. A. Rogers,** Allison Division, General Motors Corp.

The flexibility of the propeller, engine, and airplane combination introduces feedback (the load is a function of the deformation) and should be considered in the analysis. As the dynamic pressure or indicated airspeed increases, the flexibility of the structure plays an increasingly important part in the determination of the side or normal loads, as well as the propeller blade stresses. As spinners become larger their contribution in increasing the effective inflow angle at the propeller disc becomes exceedingly important.

# Where Should You Park 'Em?

**Indoor or outdoor storage for fleet vehicles is always a big question. There are advantages to both. Fleet operators tell you—from experience—both sides of the argument.**

## Park 'em Indoors . . .

**1.** if appearance and cleanliness are of primary importance, as they are with bakery and food trucks. Indoor storage will make maintenance easier, cheaper, and will protect body finish from snow, rain, sun, and salt air.

**2.** if you want to improve personnel relations. Drivers appreciate getting into a warm cab without having to clear snow or sleet from the truck.

**3.** if you want your vehicle always ready for work. A warm engine starts immediately. There is less wear on the battery and ignition system. Also, less gasoline waste and engine wear. This cuts down road breakdowns. One transit company reduced road calls 2½ times by storing buses inside.

**4.** if you are in a zone where severe winters are the rule. Sometimes adequate protection can be obtained by constructing a shed or "car-port" over an open lot, and providing engine block heaters.

**5.** if all vehicles must be loaded simultaneously with perishable merchandise.

## Park 'em Outdoors . . .

**1.** if the capital investment put into constructing a garage can be put to better use elsewhere. One oil fleet operator found that outside storage was 40% cheaper than garage storage if amortization of garage was taken into account.

**2.** if your vehicles are used for more than one shift per day. Since they are on the road most of the time, a garage for the few hours they are not used is not worthwhile.

**3.** if you are willing to go to the expense of supplying electric, hot air, or infra-red heaters to warm up engines before starting. Water jacket temperature should be maintained above 40 F. Also, the ignition system should be protected by a moisture-proof coating.

**4.** if you're in a southern climate zone where climate is so mild that only a paved parking area is needed.

**5.** if an enclosed loading platform is provided.

**6.** if your business is expanding. Garage space is often outgrown in a few years as truck size increases and new vehicles are added to the fleet.

**7.** if an enclosed maintenance and service garage is provided.

**8.** if you want to increase the safety from fire. There are less gas fumes problems and fires are easier to fight outdoors.

In summary, for most fleet operators capital investment in storage garages is not economically justified. If you are willing to spend more money to keep up outward appearances, then indoor storage is the answer. However, less expensive substitutes, such as sheds and engine heating devices, will give adequate protection from the weather at comparatively low cost.

**This article is based on papers presented at SAE National Transportation Meeting, Boston, Oct. 19, 1954. Individual papers are available in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.**

***Bakers Like Enclosed Storage***
—R. W. Thomas, Quality Bakers of America, Cooperative, Inc.

***Are Storage Garages Economically Justified?***
—J. M. McGinnis, Shell Oil Co.

***Relative Merits and Economies of Inside and Outside Storage of Transit Vehicles***
—R. M. Knutsen, Cleveland Transit System

***Discussion***
—A. W. Neumann, The Willett Co.

# Diesels Wear Less with

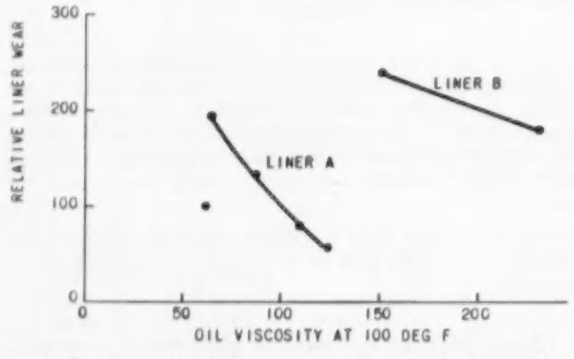



Fig. 1—Two different cylinder liners were used in 2-stroke engine. With the first, a series of very light lubricants was used, and large differences in wear, favoring the thicker oils, were found. Same trend seemed to be shown with second liner with two oils of higher viscosity

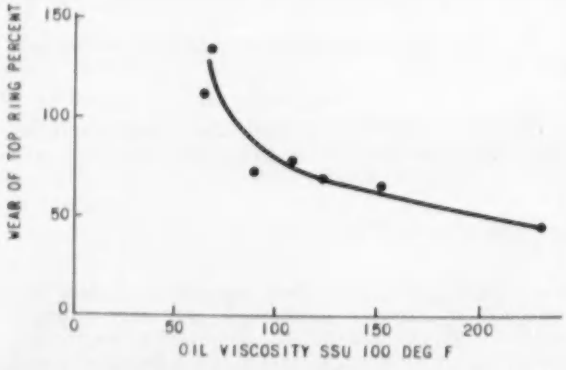



Fig. 2—Though operated at low jacket temperature (117 F), 2-stroke engine at full load and 1200 rpm showed high ring wear when very light oils were used

LUBRICANT failure—a primary cause of contact wear in diesel-engine cylinders and rings—can be eliminated with lubricants having:

- Increased high-temperature viscosity.
- Decreased volatility.
- Maximum thermal stability.

The effect of increasing the oil viscosity on liner wear is shown for two different liner materials in Fig. 1 and for piston rings in Fig. 2. Note in Fig. 1 that, with extremely light oils, the durability of the liner improves very rapidly with increasing viscosity. In Fig. 2 note that a very rapid improvement in oil film effectiveness is seen as viscosity at 100 F is increased to about 100 SSU, with more gradual improvement thereafter.

Evidence of this character raises question on how to use mineral oil in arctic operation, where very light viscosity is required to permit cranking. On demand, full power output of the engines must be produced, and cylinder surface temperature therefore will be as high as, or higher than, that prevailing in normal temperature climates, because this temperature is apt to be aggravated by the use of glycol antifreeze.

These factors led the Bureau of Ships, U. S. Navy, to contract for a test program with the Southwest Research Institute, San Antonio, which was designed to reveal the separate contributions of viscosity, initial and average volatility, and residual volatility of the lubricating oil to the prevention of piston-ring wear. Pursuant to the plan, most of the test oils were of Navy 9005 or MIL-O-10295 type, essentially 5W oils, having viscosities at 210 F of about 45 SSU, and viscosity indices of 140 to 160 in order to be fluid at low temperatures and yet have the viscosity of SAE 20 oils (approximately) at cylinder surface temperature. These were light mineral oils with viscosity-index improvers. In addition, an SAE 30 oil (Navy symbol 9030) served as a high-viscosity standard, and a turbine oil based

# Oils of

## 1. Increased high-temperature viscosity
## 2. Decreased volatility
## 3. Maximum thermal stability

**H. V. Nutt,** U. S. Naval Engineering Experiment Station,
**E. W. Landen,** Caterpillar Tractor Co., and
**J. A. Edgar,** Shell Oil Co.

Based on paper, "Effect of Surface Temperature on Wear of Diesel-Engine Cylinders and Piston Rings," presented at the SAE National West Coast Meeting, Los Angeles, Aug. 18, 1954. This paper will be published in full in the 1955 SAE Transactions.

on di-2-ethylhexyl sebacate was included as an example of a more favorable volatility than can be had in a natural oil of like viscosity. In the 9005 oil class, two extremes were represented: first, oils made with well-selected base stock which had the lowest possible volatility commensurate with the desired fluidity, and second, oils made with light naphthenic base stocks which had an unfavorable volatility (low boiling points) at the required viscosity. Not to neglect the possible influence of heavy residual components, bright stock was compounded with one of the naphthenic oils.

When used in a 2-stroke diesel engine with all piston compression rings irradiated except the top ring, the oils were found to differ in the power they would permit to be drawn from the engine before ring wear became excessive. Bmep was increased regularly in 14-psi changes at half-hourly intervals with all other factors constant. Wear, indicated by the radioactivity (counts per minute) of the circulating oil, goes on at a fairly low, steady rate until conditions of time and load are reached which tend to produce a considerable increase in wear. If straight lines are drawn representing the average rate of wear before and after this change occurs, characteristic wear patterns such as those shown in Fig. 3 are produced.

In some cases the time and load conditions for

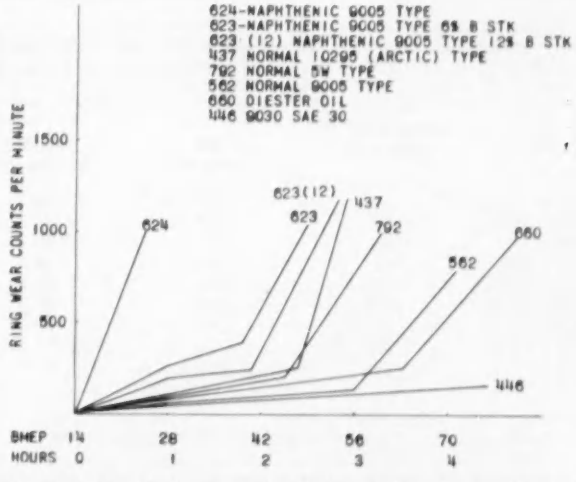



**Fig. 3—A 2-stroke diesel was fitted with a radioactive top ring, and run with many oils, which differed in viscosity and in the relation of viscosity to volatility. Speed was 1200 rpm, load increased in half-hourly equal steps (hourly values only shown on graph). Radioactive iron debris in oil emanates rays proportional to its quantity (counts per minute). Generally, onset of contact wear is believed to be shown by abrupt change in wear rate, or knee of a particular curve**

**CONTACT wear—usually a disease of diesel engines having high loads and hot surfaces—can be reduced by:**

**1. Lowering the temperature of inner cylinder surfaces.**

**2. Using lubricants better able to withstand the high temperatures and loads at these surfaces.**

**The authors' discussion of the second of these methods is presented here. The complete paper covers both ways of reducing contact wear.**

rapid wear may approach zero time and load. This is indicated by the curve for oil 624, which is shown to start out in the high wear stage at a rate of about 1000 counts per min per hr. This rate, if allowed to continue, produces permanent scoring and engine failure. The slopes of the post-knee portions of the curves of the other oils shown are less precipitous, but all rates are intolerably high for good service. Therefore, the knee of the curve is considered the load for failure. Going from left to right, or from bad to good, in Fig. 3, and noting load/time at the knee of each curve, the oils are aligned in order of merit in Table 1. (Because load was not varied in infinitely small steps, it has been necessary in some cases to interpolate, which is to express a greater time at a given load as though it were a greater load only. This is incorrect, but does not alter the sense of the performance comparison.)

Two criteria of volatility are listed in Table 1. The first is derived from the property of the oil to vaporize in a Vacuum Engler apparatus at a pressure of 1 mm mercury absolute as temperature is increased at a regular rate. In this apparatus it is possible to boil off about 80% of the usual light mineral oil or light synthetic oil before a temperature is reached where the residue begins to decompose and the regularity of the process is disturbed. The synthetic oils are seen in Fig. 4 to have high initial boiling points; as much as 50% of the best light mineral oil will have disappeared from the flask before the first drop of the synthetic oil is vaporized. However, this type of assessment evidently emphasizes *initial* volatility because it does not tell quantitatively whether a useful residue would remain on the cylinder wall after some or most of the oil had been flashed off. If the 20% evaporated points of the oils are listed, as in the table, and compared with engine performance quality, it is seen without plotting that the relation is not regular, and that there is at least one important inversion of order. This suggests that an inspection method is needed which will measure the persistence of an oily residue after the oil has been heated in a thin film. "Loss on heating" or its inverse "residue after heating" has been used for this purpose in various lubrication studies, and in this case a large number of combinations of temperature, time, and film thickness conditions were surveyed to develop a reproducible test which would seem to have connection with the engine performance values of the oils. The most suitable conditions found were as follows:

Thickness of oil film: 0.15 mm
Heating condition (oven, forced draft): 300 F
Time: 2 hr

The last column of Table 1 shows only a roughly

**Table 1—Viscosity and Volatility Characteristics of Variety of Oils (Arranged in Order from Worst to Best)**

| Oil No. | Load, Bmep at Failure, psi | Viscosity, SSU | | V.I. | Volatility | |
|---|---|---|---|---|---|---|
| | | At 100 F (Measured) | At 300 F (Extrapolated) | | 20% Distilled Temperature, F | Residue after Heating, % |
| 624[a] | 14 | 128 | 35.7 | 153 | 308 | 15.0 |
| 623[b] | 35 | 138 | 35.6 | 141 | 300 | 20.0 |
| 437[c] | 37 | 118 | 36.4 | 162 | 258 | 8.5 |
| 624 + 12[d] | 42 | 164 | 36.5 | 140 + | 305 | 23.0 |
| 792[e] | 45 | 110 | 35.4 | 165 | 314 | 47.0 |
| 562[f] | 50 | 164 | 36.8 | 145 | 376 | 61.0 |
| 660[g] | 56 | 72 | 32.0 | 125 | 434 | 93.8 |
| 479[h] | 59 | 74 | 32.7 | 160 | 426 | 92.7 |
| 446[i] | 70 | 582 | 41.7 | 100 | Decomposed at 430 | 93.8 |

[a] Navy 9005 type, naphthenic.
[b] Navy 9005 type, naphthenic, with 6% bright stock.
[c] 10295 type (Army Arctic).
[d] Navy 9005 type, naphthenic like 624 and 623, but with 12% bright stock.
[e] SAE 5W commercial type.
[f] Navy 9005 type.
[g] Diester, di-2-ethylhexyl sebacate.
[h] 7808-type aircraft turbine oil, based on diester.
[i] Navy 9030 type, SAE 30 viscosity, synthetic.

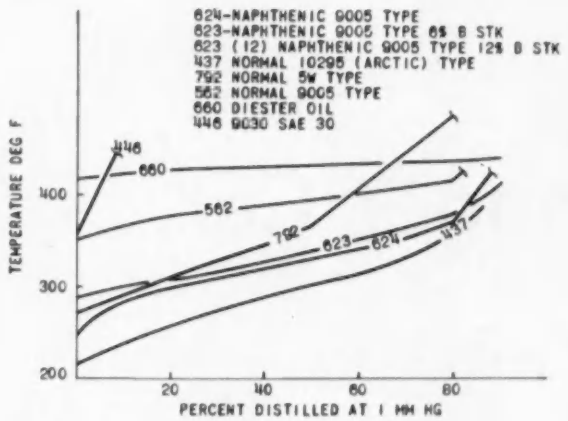

624-NAPHTHENIC 9005 TYPE
623-NAPHTHENIC 9005 TYPE 6% B STK
623 (12) NAPHTHENIC 9005 TYPE 12% B STK
437 NORMAL 10295 (ARCTIC) TYPE
792 NORMAL 5W TYPE
562 NORMAL 9005 TYPE
660 DIESTER OIL
446 9030 SAE 30
TEMPERATURE DEG F
PERCENT DISTILLED AT 1 MM HG

Fig. 4—When oils are distilled in Vacuum Engler apparatus at 1 mm mercury absolute pressure, an indication of relative resistance to vaporization is obtained; but unfortunately this test applies only to the more volatile part of the total oil, and gives little idea of the nature of high-boiling residues. Judged by this distillation method alone, 10295 and naphthenic 9005 oils would be picked as the poorest of the series, and synthetic oils the best. This is roughly correct, but the order of engine rating does not agree exactly

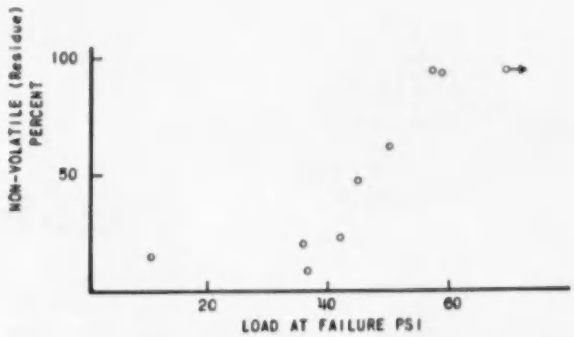



Fig. 5—Information on oil volatility obtained by vacuum distillation (see Fig. 4) can be augmented by a thin film evaporation test, where resistance of oil to loss from a heated dish is measured. In this case oil film was 0.15 mm thick, temperature 300 F in air, and time 2 hr. Good general agreement is seen between amount of oil remaining after this heat-treatment and load which engine would carry before contact wear set in. Load is expressed in bmep at 1200 rpm

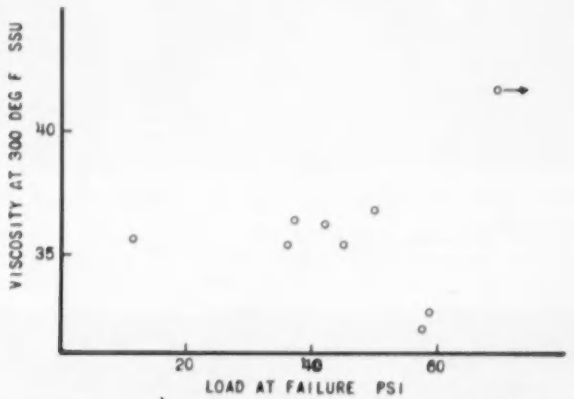



Fig. 6—If viscosity of oil is considered without reference to its volatility, very poor agreement with the property of cylinder film lubrication results. This observation was made clear in these tests by using oils of greatly differing volatility-viscosity relationships. However, Fig. 5 shows that resistance to evaporation is a better single performance indicator than is viscosity

systematic performance increase with residue after heating, and minor inversions occur. The degree of correlation is shown better by Fig. 5.

Whatever the shortcomings of the volatility criterion may be, it is better than a judgment of performance based on viscosity alone. Fig. 6, when compared with Fig. 5, leaves no doubt on this point.

The wear data under discussion do not decry the importance of viscosity, but they do emphasize that:

*For cylinder lubrication, low oil volatility is essential, and this property is best recognized by measurement of the quantity which remains after exposure of a film of oil to high temperature.*

Low volatility assures merely that a viscous film will survive the flash evaporation which occurs on the cylinder at each power stroke. Sufficient oil must remain to make a hydrodynamic film or contact wear will result.

Viscosity and volatility being independent variables, a multiple correlation should be possible. For the tests described, a rather good curve fit is obtained by the simple linear expression:

$$F = -2 + 0.3R + 0.9V$$

where:

$F$ = Load capacity
$R$ = Per cent residue after heating
$V$ = Extrapolated viscosity, SSU/300 F

This expression of the wear test results is plotted in Fig. 7. It would not be expected that the terms would apply to all other conditions and engines, but it is confidently proposed that a similar type of correlation will prove to be adequate to compare oils under any situation where the condition of contact cylinder wear may be reached.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

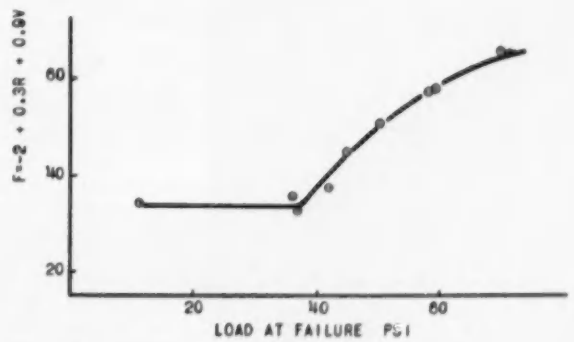



Fig. 7—Linear combination of volatility and viscosity criteria produces a correlation between these properties of oils and their protective value against piston-ring contact wear. "Load at failure" again is expressed in bmep which could be drawn from engine at 1200 rpm before evidence of contact wear appeared

# Passenger Car, Body, and Materials Meeting

## *Links*

# OPPORTUNITY with

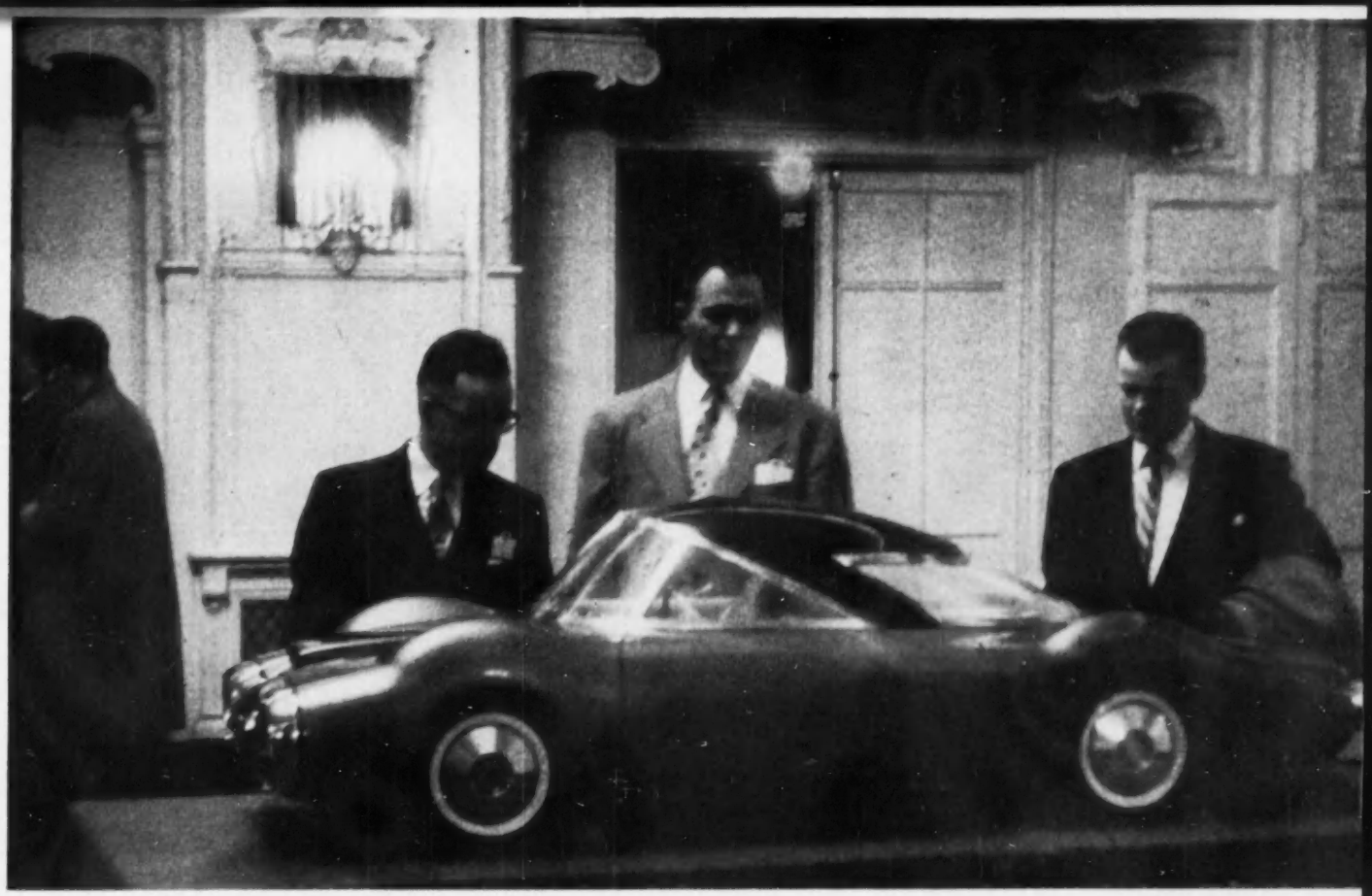
**TOASTMASTER,** Harvey Campbell, V.P. of the Detroit Board of Commerce, looks over his notes before the dinner

OPTIMISM joined opportunity in knocking on the door of the 1955 Passenger Car, Body, and Materials Meeting, at the Sheraton-Cadillac Hotel, Detroit, March 1–3. Several papers presented at the technical sessions and the dinner speeches foresaw a prosperous future, providing the industry takes advantage of today's opportunities.

C. G. A. Rosen, SAE President, expressed it succinctly at the dinner Thursday evening when he said, "This is a golden year of golden opportunity. We must measure up to a golden standard." Explaining further, he said, "Future economic security rests more on the creative thinking of our engineers than on our natural resources."

The Federal Government also looks with hope to the future. Arthur S. Flemming, Director of Defense Mobilization, Executive Office of the President, told the gathering that war is not inevitable, providing the United States builds its human and physical resources strong enough to deter Russia from starting one.

The Government believes, Flemming said, that the threat of war will last at least another 50 years. This threat is an ever present danger since Russia has now the capability to attack continental United States. In defense, a program for mobilizing industry is already underway. Four and one-half billion dollars of 76 strategic materials have been stockpiled. Industry is being encouraged to build new production facilities and disperse throughout the country. A trained nucleus of technical personnel, both civilian and military, is constantly being expanded.



SCALE MODEL OF FUTURISTIC AUTOMOBILE DRAWS PROFESSIONAL APPRAISAL FROM SAE MEMBERS

# OPTIMISM

Civilian Defense activities are being increased and an early warning radar network is top priority.

In filling these defense gaps, the attitude of the government seems to be we can make the future safe and prosperous by careful, forceful planning today.

The idea of optimistic preparedness can be used to good advantage in private industry, too. As explained by W. B. Harris, of *Fortune*, by 1960 there will be an unprecedented increase in buying power in the middle income groups. This can result in greater national prosperity if plans are made now.

Other technical sessions illustrated the immense potentials for new synthetic materials, "wonder" alloys, and new approaches to current problems.

Continued on following pages

**RING 'ROUND AN ENGINE** separates Packard's new V-8 from ring of interested spectators. Also on exhibit during one of the evening sessions was a cut-a-way model of the 1955 Plymouth V-8 engine

**GUEST SPEAKER** Arthur S. Flemming, Director of Defense Mobilization, speaks on "The Nation's Defense Program" before 421 dinner guests

**PROGRAM SHARERS** W. P. Eddy, Jr. (left) Engineering Materials Vice-President and his Meetings Vice-Chairman M. L. Frey (right)

**BODY ACTIVITY** Vice-President H. S. Kaiser (right) and his Meetings Vice-Chairman, K. E. Coppock (left) chat with Detroit Section Chairman H. E. Chesebrough at the reception

For the smooth operation of the Meeting's technical sessions, SAE is grateful to chairmen:

**V. D. Polhemus,** General Motors Corp.

**C. F. Nixon,** General Motors Corp.

**R. W. Fogerty, Jr.,** Continental Division, Ford Motor Co.

**W. E. Jominy,** Chrysler Corp.

**H. F. Copp,** Continental Division, Ford Motor Co.

**H. E. Churchill,** Studebaker-Packard Corp.

**L. A. Kintigh,** Oldsmobile Division, General Motors Corp.

**J. B. Macauley, Jr.,** Ethyl Corp.

And for their services in recording the discussion at the sessions, SAE thanks secretaries:

**L. C. Lundstrom,** General Motors Proving Ground

**T. O. Mathues,** Inland Manufacturing Division, General Motors Corp.

**G. M. Buehrig,** Continental Division, Ford Motor Co.

**V. C. Ayres,** Eaton Manufacturing Co.

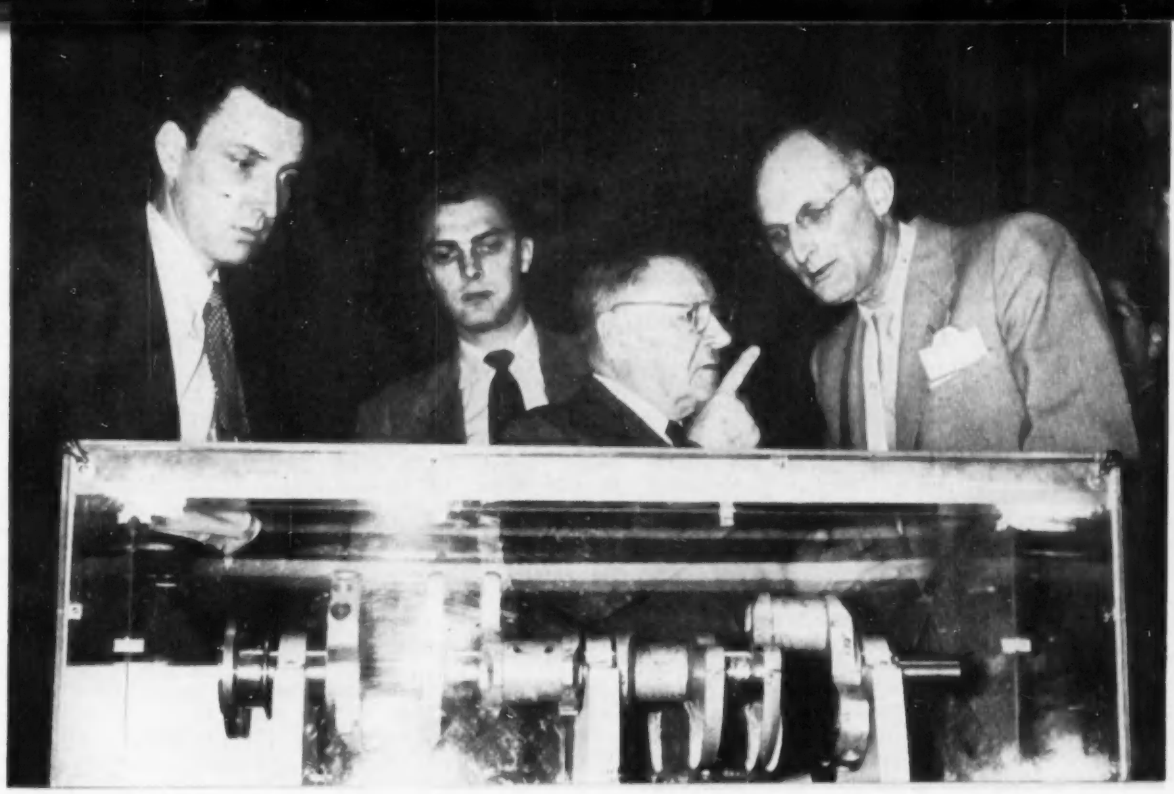
**K. H. Higgins,** Continental Division, Ford Motor Co.

**H. R. Johnson,** Studebaker-Packard Corp.

**T. H. Thomas,** Bendix Aviation Corp.

**J. S. Wintringham,** Ethyl Corp.

**BIG SMILES** light faces of R. F. Kohr, Passenger Car Activity Vice-President (left) and 1955 SAE President C. G. A. Rosen (center), while H. C. Grebe, General Chairman of the meeting (right) welcomes members to Detroit



**INFORMED MEMBER** explains to colleague the meaning of the stress coat test markings on this alloy steel cast crankshaft exhibited at a technical session. Crankshaft, from Packard's V-8, weighs 65 lb rough and 56 lb machined

# Many Problems . . . Some Controversy . . . Few Solutions

## Technical Sessions Explain "Why"—Search for "How"

"WE haven't solved all our problems, but we certainly know more about them than when we came in." This statement by W. E. Jominy, Chairman of the Symposium on Camshafts and Tappets, pretty well sums up the tenor of the Passenger Car, Body, and Materials Meeting. Papers at the three-day Detroit gathering, for the most part, explained thoroughly why a problem existed and reviewed what had been tried in the past to solve it. But actual solutions to these problems had to be left to future meetings or to individual engineers to work out on their own.

For example, tire thump is believed to be caused by the resonant vibration of parts of the car and tires at a beat frequency equal to wheel rotational speed. Although a meter has been devised to measure tire thump noise, and much has been learned about the nature of thump at various speeds, no solution to the complex problem has been found yet.

Detuning the resonant systems, isolating the disturbance from the passenger compartment, or changing tire construction are possible ways of eliminating tire thump.

Another problem, the unsatisfactory performance of rubber when used for applications other than tires, received careful consideration.

It seems rubber is not flexible enough at low temperatures, and will not withstand deterioration when in contact with hot oils and solvents. Therefore it makes inadequate fluid seals. When used for V-belts it doesn't have strong enough dynamic tensile strength. When used as a weatherseal, it

cracks, shrinks or stains adjacent metal parts. Replacing rubber with new materials such as polyester isocyanate elastomers and plastics may be possible in the future. But more experimental work is needed first.

Probably the most important industry problem, and certainly the one which drew the largest audience, was the symposium on "Camshaft and Tappet Materials, Treatments, Lubricants, and Designs." Although this subject is perennial at SAE meetings, new light was thrown on wear life.

Lubrication was found to be a minor factor in cam scuffing of alloy iron tappets and camshafts. Hardenable cast iron tappets seem to resist fatigue and scuffing better than chilled cast iron. Therefore, the trend in the industry is toward hardenable cast iron. But, the type of material is not as important as the metallurgical and mechanical *compatibility* of the two types of materials used for tappets and for cams.

Why Plymouth and Packard designed their 1955 V-8 engines the way they did was the subject and impetus for a long and lively discussion.

Plymouth designed a modified hemispherical combustion chamber because "extensive tests showed it would give the greatest volumetric and thermal efficiencies, with the smoothest combustion."

Packard, on the other hand, after equally extensive tests decided on a wedge-shaped chamber. Packard says the high turbulence wedge-type chamber provides for a "lower burning rate of the charge and avoids a high rate pressure rise, thereby promoting smoothness."

This "difference of opinion that makes horse races" showed that some design problems have no absolute solution. Both designs have advantages and disadvantages. Probably the bore-to-stroke ratio is the most important variable causing the controversial differences in chamber configuration.

Problems encountered in designing and manufacturing body structures were also reviewed. Keeping costs down, body stiffness up, and weight down, in spite of the unusual styling in new cars, are the main problems. There is some hope that plastics will be the answer, but at present they lack the necessary stiffness. Much weight can be saved by using unit bodies and taking advantage of the compressive strength in the glass used in new cars.

A solution to a major automotive problem—brakes that meet the stringent requirements of high-speed cars—was suggested at the meeting. A new double disc brake is said to overcome many of the disadvantages of the conventional drum brake. It dissipates heat rapidly through its die cast aluminum housing. It is self-energized to greater and smoother braking power. An automatic adjustment compensates for lining wear, thereby reducing adjustment and repair.

Other papers on a wide variety of subjects were presented at the meeting. Excerpts of interesting highlights follow:

**POSSIBLE PASSENGER CAR** of the future (Ford's Muroc) is inspected by F. R. McFarland, Meetings Vice-Chairman for the Passenger Car Activity

## Tire Thump

Tire thump is due to the simultaneous excitation of at least two audio frequency sound components which are adjacent harmonics of wheel rps and which have approximately equal sound pressure amplitudes. These components interfere with each other to produce a beat frequency equal to wheel rps, which is heard as tire thump. . .

. . . **D. C. Apps and G. M. Vanator, General Motors Proving Ground,** "Tire Thump, Its Mechanism and Measurement."

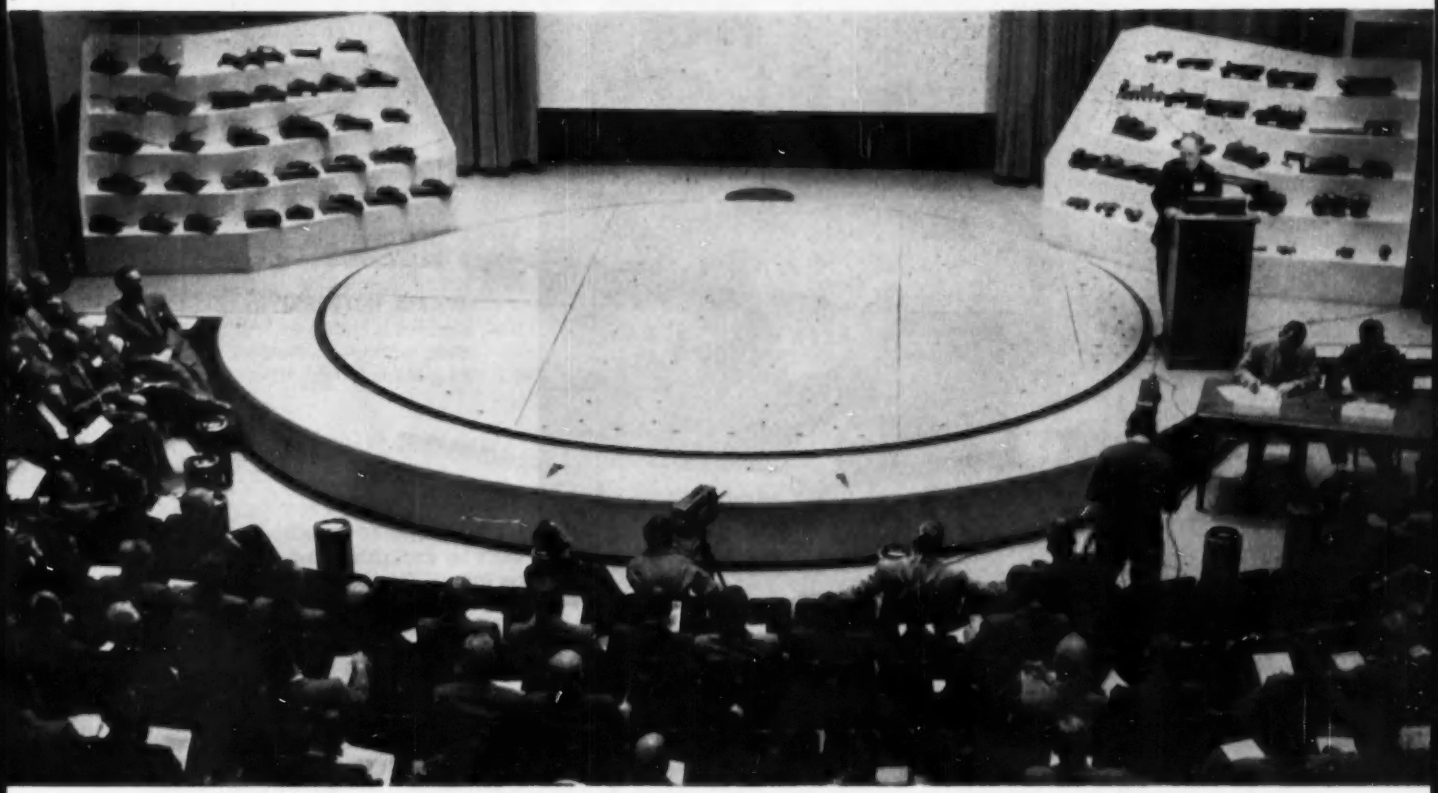
## Automobile Market Changing

The future market will not be a competition for unit sales. It will be a competition for the consumer's dollar by the whole industry. It's a new kind of competition brought about by the changing American automobile. It rests upon the industry to sell annually more and more car per car. . .

. . . **W. B. Harris, Fortune Magazine,** "The Market for the Changing American Automobile."

**Continued on page 120**

# SAE INSPECTS DETROIT TANK ARSENAL



SAE IS WELCOMED IN NEW AUDITORIUM BY COL. H. C. PARSONS OF DETROIT TANK ARSENAL

## Finds Ordnance Corps is Cost Conscious

**MODERN warfare is so expensive that the nation which can field the most effective military force at the lowest cost will have the best chance of winning.**

**So, the Army Ordnance Corps is extremely cost-conscious in developing vehicles for military use. This was pointed out in several ways during the visit of the SAE to the Detroit Arsenal, Centerline, Michigan, on SAE's First Automotive Ordnance Day, Feb. 28, 1955.**

**Over 1000 reservations for the tour threatened to tax the facilities at the new tank center. But the eager crowd which overflowed the auditorium was well taken care of by a closed TV circuit piped to additional viewing rooms.**

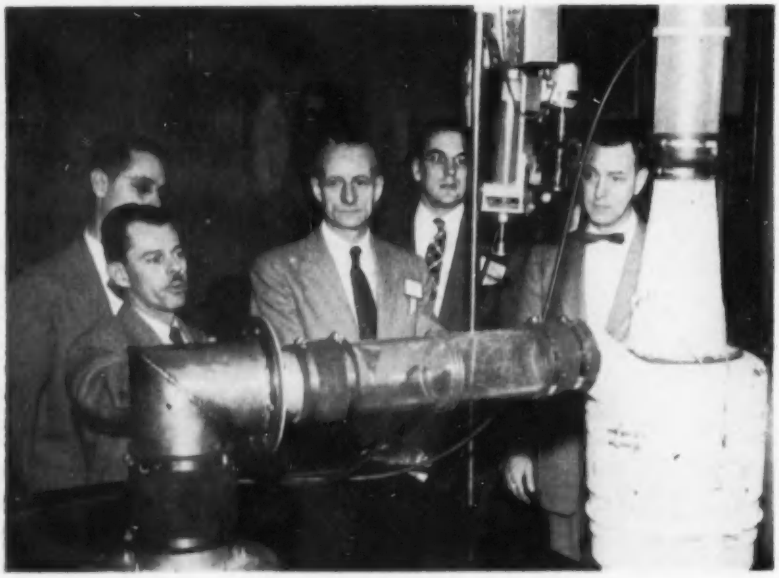
**ON TOUR OF ARSENAL, SAE** engineers see how Army Ordnance evaluates the effect of various turret unbalances upon the control system of an M47 Medium Tank. Tours were conducted throughout the day to laboratories, test cells, model shops, research and development divisions, offices, and test tracks.

**Continued on next page**

**ORDNANCE DAY CHAIRMAN** C. F. Bachle, Continental Aviation and Engineering Corp., is shown a scale model of a proposed Army tank design by Col. G. T. Petersen, Officer in Charge of the Research and Development Division at the Detroit Arsenal. Col. Petersen conducted the morning session and described Arsenal facilities

**WARM INTEREST** in cold-test procedures is shown as SAE members look over workers' shoulders. Other side of glass is a cold test cell at - 70 F

**ATTENTIVE LISTENERS,** in Powerplant Laboratory, hear explanation of dust test for air cleaners used in tanks. Humidity, temperature, and dust content can be controlled to simulate field conditions closely. Construction of a one-mile high-speed test track and test slopes are planned but as yet unfunded



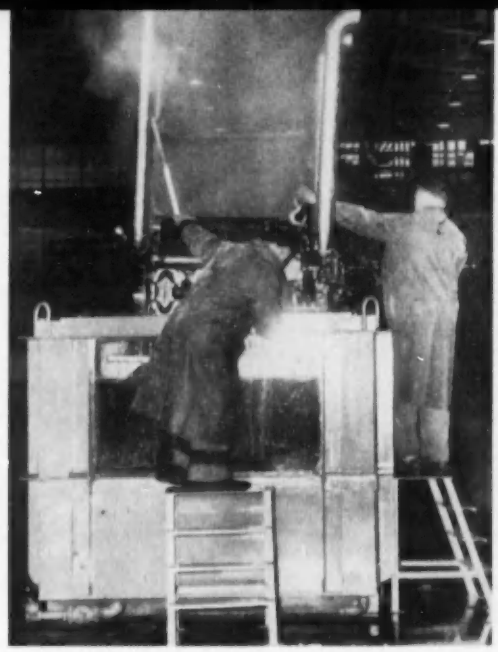
**"Economy is equally as important in designing combat vehicles as our other cardinal objects—effectiveness, ruggedness, and simplicity," Colonel George T. Peterson, in charge of Research and Development at the Arsenal, told the gathered automotive engineers.**

**Major General E. L. Cummings, Chief of Ordnance, Department of the Army, re-emphasized this. Vehicles that are fast, maneuverable, adaptable to extreme conditions, and economical to produce and maintain, are still vital to a modern army, because "atomic super weapons and pushbutton warfare will not do away with ground troops who must move in and take control."**

**A World War II medium tank cost about $86,000, or $1.30 per pound. Even with today's high prices that push the cost of a tank to $105,000, it has been possible to decrease per pound cost to $1.03. This was the result of the combined efforts of Ordnance and industry to cut costs without cutting effectiveness.**

**Standardizing engines and parts for military vehicles was one such effort. The "family" idea of vehicles which provides maximum interchangeability of parts within and between various vehicles was developed at the Detroit Arsenal. It has already saved millions in manpower, production, supply, and maintenance.**

**For instance, the number of high mortality parts in engines used by the military was reduced**



**DUNKING ENGINE** in tank of water demonstrates it will run while completely submerged. Intake and exhaust snorkels permit it to breathe

86%. Thus, the necessary stockpiling of replacement parts could be reduced and transportation space saved for other critical materials. With fewer types of engines, training maintenance personnel becomes simpler and faster. More vehicles are made available at the battlefront. And parts can be manufactured in quantity at lower cost.

Simplicity of design is another way to reduce cost. Complex equipment requires skilled personnel and long training time. Both are expensive and rarely available in wartime. By keeping Ordnance designs as simple as possible, great economies can be made in manufacturing, maintenance, and operation, provided there is no sacrifice in ruggedness or effectiveness.

One of the projects now underway at the Arsenal is reducing the weight-to-power ratio of armored vehicles, thereby increasing range, speed, and maneuverability. Replacing steel by titanium, which is as strong as most heat-treated steels and only 56% as heavy, would be very desirable. Titanium resists corrosion better than aluminum or steel, is very ductile, and has high fatigue values. But at present it costs $15.00 per pound. This is too high for general use.

Another project which could save millions and have immense influence in the non-military field is the development of an engine that can operate equally well on gasoline, diesel, JP-4 gas turbine fuel, or even crude oil. A multi-fuel engine would give the Army much more independence and mobility in foreign lands, simplify logistics, and increase an armored division's range 60%. The Arsenal is on the verge of perfecting such an engine.

Unfortunately the Army cannot use existing commercial truck engines in its tanks because they take up too much valuable space. And because of the scarcity of diesel fuels, the Army can't take full advantage of the good economy inherent in diesel engines. Colonel Petersen reminded SAE engineers that, as much as the Army would like to use only compression ignition engines, this is impossible. As long as American passenger cars use gasoline, Army vehicles must also be built to run on gasoline. Then, in the event of war, all civilian fuel and refineries can be diverted to the military.

Of course, in the future, nuclear power may supersede chemical fuels. The Ordnance Corps at the Arsenal is investigating the possibility of a reactor powered tank. A design currently being considered looks much like a conventional heavy tank, but has a potbelly and additional traction

**ENGINE INTERCHANGEABILITY** is basic idea of the Detroit Arsenal's "family concept" of military vehicles

**LIVING FUNGI** are examined carefully for effects on non-metallic materials. Tests are conducted in tropical temperature and humidity incubators; cultures of fungi are kept in living files. Arsenal also has a fuels and lubricants lab

wheels. However, it would weigh over 70 tons, which is too heavy for practical use. Since the Army is looking for lighter-weight, more maneuverable vehicles, it seems unlikely that an atomic-tank will be operational in the near future.

Other researchers are developing the Orion engine, which combines the lower weight of a gas turbine with the fuel economy of the diesel.

Still in the dream stage are solar engines, vehicles powered by energy broadcast from central "radio stations," and flying tanks held aloft by magnetism. But whether the future tank will have spark ignition, compression ignition, gas turbine, atomic, or "Buck Rogers" power plants, will depend greatly on the cost of developing, producing, and maintaining them in the field.

Looking to the future, the Detroit Arsenal believes that tomorrow's wars are won by battles fought in laboratories today. Since the lead time necessary for an ordnance idea to go through design, development, testing, and production takes from three to five years, the Arsenal's mission is a vital one. That is why nothing has been spared to make the Arsenal the most up-to-date, well-equipped research and development center in the world.

Construction of labs and test facilities on the square mile Arsenal grounds cost over 50 million dollars and is continuing. The Arsenal feels 25 million dollars a year is required to do a good job of keeping ahead of the enemy. Of this yearly budget about 25% is spent at the Arsenal, primarily to keep a nucleus of qualified personnel up to date on ordnance and automotive developments. 75% goes to private enterprise in contracts. Ordnance at present has 400 contracts with 324 educational institutions, research organizations, and industrial concerns totaling 55 million dollars.

At the Arsenal itself over 1500 people are developing and testing prototype vehicles and components. The Arsenal works closely with the automotive industry setting standards, and inspecting ordnance equipment. But mass manufacture is farmed out to private industry. Thus there will always be available adequate production facilities in the event of total mobilization.

**Highlights from technical papers presented at the afternoon session follow:**

## Titanium For Tanks

Titanium is equivalent in strength to most heat-treated steels and only 56% as heavy. Its resistance to corrosion is considerably better than that of aluminum or steel. It possesses excellent qualities of ductility as well as high fatigue values. Therefore, there are great possibilities for using this metal for armored vehicles. . .

. . . **J. G. Stefanich, Research and Development Division, Detroit Arsenal,** "Utilization of Titanium for Tank-Automotive Components."

## Air Cleaners For Tanks

Oil bath air cleaners for combat vehicles perform satisfactorily, but new high speed engines requiring twice the amount of air have more stringent requirements. A cleaner with a dry type felt element integrated with a precleaner which is self-cleaning looks promising to fill the needs. . .

. . . **Edward Blackburne and C. R. Denton, Research and Development Division, Detroit Arsenal,** "Air Cleaners for Military Vehicles."

## Analog Computer

The analog computer can multiply by a constant, integrate quantities with respect to time, and multiply variables. These operations depend on the impedances that are placed in the feedback and input circuits of the amplifier. All physical parameters are expressed in terms of voltages. . .

. . . **Thomas Wood, Research and Development Division, Detroit Arsenal,** "The Use of Analog Computers in Design of Military Vehicles."

**RAPT ATTENTION** is given by Army Command Officers as fine points of tank track design are pointed out. Left to right: Col. G. T. Petersen; Maj. Gen. E. L. Cummings, Chief of Ordnance; Col. H. C. Parsons; Brig. Gen. P. M. Seleen, CG of Ordnance Tank-Automotive Command

# SAE Section Meetings . . .

### Atlanta—May 2

Ship-A-Hoy Restaurant. Dinner 7:00 p.m. Meeting 8:15 p.m. Subject not known. V. G. Raviolo, executive engineer, Lincoln-Mercury Division, Ford Motor Co., Dearborn, Mich.

### Alberta—April 21

Technical Meeting.

### Baltimore—April 14

Golden Anniversary Meeting.

### British Columbia—May 9

Georgia Hotel Ballroom. Golden Anniversary Meeting.

### Canadian—April 22

Prince Edward Hotel, Windsor, Ontario. Dinner 7:00 p.m. Meeting 8:00 p.m. G. E. Meese, Lamp Division, General Electric Co., Cleveland.

### Central Illinois—April 13 and 14

Hotel Pere Marquette. Earthmoving Industry Conference.

### Chicago—April 14

Knickerbocker Hotel. Dinner 6:45 p.m. Meeting 8:00 p.m. "Future of Engineering From The Technical Standpoint"—Dr. Richard Folsom, director of engineering, University of Michigan. Toastmaster — Dr. D. P. Barnard, deputy assistant secretary of Defense—SAE Past-President. Social half-hour 6:15 p.m. Golden Anniversary Meeting. Guest—F. G. Shoemaker, SAE Council.

### Detroit—April 20 and May 9

**April 20**—Dearborn Engine Plant, Ford Motor Co. 7:00 p.m. Junior Group Field Trip. Open to SAE Junior members only.

**May 9**—Chelsea, Michigan. Tour of Chrysler Corporation Proving Ground. Open to SAE members and applicants only. Details to be announced.

### Metropolitan—April 13, May 5 and 18

**April 13**—Passenger Car & Body Meeting. Engineering Societies Building, 29 West 39th St., New York. Meeting 7:45 p.m. "Indianapolis Racing Car Design"—R. T. Jackson, Perfect Circle Co.

**May 5**—Transportation & Maintenance Meeting. Brass Rail Restaurant, Fifth Avenue between 43rd and 44th Sts., New York. Cocktail hour 5:30 p.m. Dinner 6:30 p.m. Meeting 7:45 p.m. "Heavy Duty Hydramatics"—W. W. Edwards, General Motors Corp.

**May 18**—Air Transport Meeting.

### Mid-Continent—April 15

Golden Anniversary Meeting. Guest of honor speaker—Robert Cass, SAE Past-President.

### Mid-Michigan—May 9

Saginaw Country Club. Dinner 6:30 p.m. Meeting 8:00 p.m. "A Carriage for My Lady"—Maurice Olley, director, Research & Development Section, Chevrolet Division, GMC. Golden Anniversary Meeting.

### Mohawk-Hudson—April 12

Circle Inn, Latham, N. Y. Dinner 6:45 p.m. Meeting 8:00 p.m. "New Techniques to Match Spark Plugs to Engines"—R. C. Teasel, research engineer, Champion Spark Plug Co., Toledo, Ohio.

### Montreal—April 18

Sheraton-Mt. Royal Hotel. Dinner 6:15 p.m. Meeting 7:45 p.m. "Fuel and Lubricant Additives"—Gordon McIntyre, manager, Technical Division, Imperial Oil Limited, Toronto, Ontario.

### New England—May 3

MIT Faculty Club. Dinner 6:45 p.m. Meeting 8:00 p.m. "Factors Promoting and Inhibiting Creative Engineering"—J. E. Arnold, associate professor, Mechanical Engineering, MIT. Student and Golden Anniversary Meeting. Guest—Robert Gardner, vice-president in charge of SAE Transportation & Maintenance Activity.

### Philadelphia—April 13

The Engineers' Club. Dinner 6:30 p.m. Meeting 7:45 p.m. "Fibre Glass Reinforced Plastic Door-to-Door Delivery Truck Bodies"—W. R. Herfurth, assistant to the vice president, Automotive Design Engineering, United Parcel Service, and "Plastics for Trailer Bodies"—S. S. Wulc, Plastics Division, Strick Co. Technical Chairman: M. K. Simkins, managing editor, Commercial Car Journal.

### Pittsburgh—April 26

Webster Hall House. Dinner 6:00 p.m. Meeting 8:00 p.m. "Looking Backward and Forward From SAE's Golden Anniversary Year"—Col. W. F. Rockwell, chairman of the Board, Rockwell Spring & Axle Co., Pittsburgh. Presentation of papers by students from Univ. of Pittsburgh and Carnegie Inst. of Technology. Guest—Robert Cass, SAE Past-President. Golden Anniversary Meeting.

### St. Louis—April 28 and May 10

**April 28**—Joint meeting with I.A.S. Ladies invited.

**May 10**—Gatesworth Hotel. Dinner 7:00 p.m. Meeting 8:00 p.m. "Automotive Fuel Additives"—Panel type meeting with four speakers representing automotive, petroleum, and additive companies. Golden Anniversary Meeting.

### Southern California—April 11 and April 20

Rodger Young Auditorium. Dinner 6:30 p.m. Meeting 8:00 p.m. "Modern Approach to Preventive Maintenance"—L. D. Conyers, shop manager, Los Angeles Consolidated Freightways.

**April 20**—SAE President C. G. A. Rosen will address SAE Enrolled Students.

### Southern New England—April 21

Yale University, New Haven, Conn. Dinner 6:30 p.m. Meeting 8:00 p.m. "Sports Car Trend"—D. R. Allen, public relations director, Sports Car Club of America, Westport, Conn.

### Syracuse—April 14

Elmira. "Carburetion"—A. H. Winkler, chief engineer, Eclipse Machine Div., Bendix Aviation Corp.

### Texas—May 13

Dallas. Dinner 7:30 p.m "Sports Cars".

### Texas Gulf Coast—May 13

Golden Anniversary Meeting. Dinner-Dance. Guest—W.C. Heath, SAE Councilor.

### Twin City—April 13

Curtiss Hotel. Dinner 6:45 p.m. Meeting 8:00 p.m. "Combustion and Deposit Problems" — Speaker from Ethyl Corp., Chicago, Ill.

### Washington—April 12

Occidental Restaurant. Dinner 7:00 p.m. Meeting 8:00 p.m. "Test Results, Boeing 707"—G. S. Schairer, chief, Technical Staff, Boeing Airplane Co., Seattle, Washington.

### Western Michigan—April 19

American Legion Hall, Grand Rapids. Dinner 7:00 p.m. Meeting 8:00 p.m. "Fleet Operation and Maintenance"—R. A. Guirlinger, superintendent of transportation, Cooper Supply Co., Detroit.

### Williamsport—May 2

Moose Club Auditorium. Dinner 6:45 p.m. Meeting 8:00 p.m. "Atoms & The Void"—H. F. Matthiesen, supervisor of contracts, Aircraft Nuclear Propulsion Div., General Electric Co., Cincinnati, Ohio.

# About

Bock

Crockett

**C. J. BOCK**, chief engineer of the General Motor Corp. Truck Coach Division, has taken leave of absence from the corporation due to illness. Bock, SAE vice-president representing Truck, Bus & Railcar Engineering in 1939, has been an active member of SAE since 1920.

Appointed to serve in place of Bock as chief engineer of the division is **C. V. CROCKETT.** Crockett has been serving as chief engineer of the Cadillac Cleveland Tank Plant.

**PHILLIP RUSKIN** is now serving as technical engineer—Propositions and Evaluations for the General Electric Co. Small Aircraft Engine Department in West Lynn, Mass. In his position, he is technical editor and writer liaison for all subsections in preparing technical reports, brochures, technical speeches and magazine articles.

Ruskin had been technical editor for Babcox Publications, Inc. in Akron, Ohio.

**DR. L. E. LIGHTON**, vice-president of The Electric Storage Battery Co., has been placed in charge of the creation of a new research division on the corporate level and expansion of research activities. Dr. Lighton's division has been assigned to work toward improvement of present lines and methods and to do basic research on future requirements for storage battery power.

Lighton

Haislmaier

**GEORGE J. HAISLMAIER** is now sales manager of the Modine Mfg. Co.'s Industrial Division, Racine, Wis. A veteran of 20 years in the heat transfer industry, Haislmaier joined Modine in 1950 with a background of 15 years in the sales and engineering of specialized industrial cooling equipment for the automotive, aircraft, agricultural, earthmoving and petroleum industries.

**FRED B. LAUTZENHISER**, retired from International Harvester Co. at the end of February, is devoting himself to several consulting assignments and to completion of a semi-technical book on highway transport. The volume will cover functional design, selection, operation, and maintenance, principal consideration being given to over-the-road types of equipment.

Lautzenhiser plans also to participate actively in the American Association of State Highway Officials Road Test, scheduled for 1956, and to continue his SAE activities.

He had been with International Harvester for many years and was consulting engineer at the time of his retirement from that organization.

**EDWARD D. KEMBLE** has been named consultant responsible for the General Electric Co.'s newly created Management Research Service Study. In his new post, Kemble will be responsible for determining what areas the company should be studying in management and organization as part of the research program in the field of management.

The G-E consultant joined the company in 1949 as manager of the automatic heating equipment plant at Bloomfield, N. J. He became manager of manufacturing for the Air Conditioning Department in 1951.

During 1954, Kemble was SAE vice-president for Production Activity.

**RAYMOND A. JUMP** has been promoted to the position of district representative in Cheyenne, Wyo., for Caterpillar Tractor Co. He had been assistant district representative.

**RICHARD G. BOWMAN**, assistant chief engineer of Republic Aviation Corp., has been awarded a citation as a "distinguished alumnus" from New York University. Bowman was an honor graduate in mechanical engineering from that university in 1931 and earned the aeronautical engineering degree in 1932. He has been serving with Republic Aviation since 1935.

**J. B. MACAULEY, JR.**, who joined Ethyl Corp. in 1945 as director of engineering research at the Detroit research laboratories, has taken office as deputy assistant secretary of defense in charge of research and development of the U. S. Department of Defense.

Macauley will be on leave of absence from Ethyl Corp. during his year of tenure with the government.

**MAYNARD B. TERRY** has been elected director of the board of directors of Dominion Brake Shoe Co., subsidiary of American Brake Shoe Co. Terry is vice-president of the Dominion Co. and president of the Brakeblok Division of American Brake Shoe.

**R. S. BRIGHT** has been promoted to vice-president in charge of manufacturing, Dodge Division, Chrysler Corp. He had been appointed to the Division's executive staff in December. In his new position he will have a wide variety of executive duties, as well as overall direction of the Nine Mile Press plant, Detroit, and the Dodge plants at Indianapolis, New Castle and Kokomo, Ind.

Bright

Zeller

**THEODORE J. ZELLER** has been elected vice-president in charge of operations of Mack Trucks, Inc. Simultaneously, he was elected a director in a Mack manufacturing subsidiary. He had been appointed chief engineer at the main assembly plant at Allentown in 1951.

**ROBERT E. KERR** is now serving Hercules Motors Corp. in Canton, Ohio as development engineer. He had previously been design project engineer with International Harvester Co. Motor Truck Division in Fort Wayne, Ind.

**KEITH J. RENISH** is now associated with the Twin Disc Clutch Co. of Racine, Wis. as project engineer. Renish had served as research engineer for Bucyrus-Erie Co. of South Milwaukee, Wis.

# SAE Members

**WILLIAM RIBANDO**, experimental engineer at the Lycoming Division of Avco Mfg. Corp., Williamsport, Pa., and SAE Williamsport Group chairman, spent the month of January in Finale Ligura, Italy. He acted as consultant to the Piaggio Aircraft Corp., who are under license to build one model of the Lycoming engine. Piaggio is ready to submit their first engine to the Italian government tests equivalent to our Civil Aeronautics Administration model tests for aircraft engines.

**GEORGE L. FRANDSEN** has taken a position with the Perfect Circle Corp. as sales engineer. He had been project engineer with Electric Auto-Lite Co. in Toledo, Ohio.

Pitt

Heath

**PAUL A. PITT** has been named chief engineer of the Solar Aircraft Co. The new engineering division that Pitt will head is a combination of the former design engineering and development engineering divisions. He has been in charge of development engineering.

**WILLIAM C. HEATH** has become executive engineer—marketing. Formerly in charge of the design engineering division, Heath will head the engineering staff of the sales division. He is a past chairman of the SAE San Diego Section and is currently an SAE Councilor and member of the Aircraft Power Plant Activity Committee.

**ARTHUR A. SCARLETT** has retired from his position as vice-president in charge of engineering for International Harvester Co. of Canada, Ltd.

Scarlett, SAE Canadian Section chairman in 1953-54, intends to spend his summers at his summer home on Lake Joseph about 150 miles north of Toronto, but will keep up his membership and activity in SAE.

**HARLOW H. CURTICE**, president of General Motors Corp., has been awarded an honorary doctor of laws degree by Michigan State College. The college has granted the degree to pay special tribute to a man who "represents the ideals and forces which have contributed to the growth of democratic education and to American progress."

**S. VERNON STOKER** has taken a position as design engineer with the McDonnell Aircraft Corp. in St. Louis, Mo. He was formerly employed as a senior detailer at the Saginaw Steering Gear Division of General Motors Corp.

**ARTHUR C. COCAGNE** has been promoted from manager of the Indianapolis office of field engineering to director of field engineering for the William R. Whittaker Co., Ltd. of Los Angeles.

**RICHARD G. SALTER** is now a research associate and instructor at Ohio State University in Columbus. His research activities include investigation of miniature engine generator sets. He is an instructor in mechanical engineering.

Formerly he had been with the Aircraft Gas Turbines Division of General Electric Co. as technical engineer.

SAE Past-President **JAMES M. CRAWFORD** has been elected secretary of the La Jolla Art Center. His paintings have recently qualified him as an Exhibiting member. Also, as a director for the past year, he has reported on the Center's membership opportunities as well as serving on the By-laws Committee.

Crawford

Roper

**VAL J. ROPER** has been appointed manager of product planning, Miniature Lamp Department, Lamp Division, General Electric Co. Roper was formerly head of the Transportation Section of the Application Engineering Department of the Lamp Division. He is currently vice-chairman of the SAE Lighting Committee and has long been active on technical motor vehicle lighting problems both in the Society and the industry and with public organizations.

**WILLIAM S. HOLLOWAY**, a designated Civil Aeronautics Administration inspector, is serving as chief inspector (manager of quality control) for Hawaiian Airmotive, Ltd., Honolulu International Airport.

Holloway had been pilot, scheduled airline, for Hawaiian Airlines, Ltd., also at Honolulu International Airport.

**C. L. RYAN** became president and general manager of Springfield Machine & Stamping, Inc., Van Dyke, Mich. in November, 1954 **and continues to hold that position.**

*SAE Journal stated erroneously on page 76 of its March issue that Ryan had left Springfield Machine & Stamping, Inc. to become associated with another organization. That statement was incorrect.*

**JOHN POLOMSKI**, as previously announced, has been appointed chief engineer of the Products Development Laboratory of Borg-Warner Corp. Since 1952 he has been supervisor of PDL's automatic transmission development, which led directly to his appointment as chief engineer.

Polomski

Barnes

**ROBERT E. BARNES** has been appointed vice-president of the Carburetion Division of American Liquid Gas Corp. He was formerly manager of carburetion sales and has been associated with the company for a considerable length of time. Barnes, a member of the Automotive Council of Los Angeles, has contributed much to the growth and expansion of propane carburetion equipment in recent years.

**JOHN K. NORTHROP**, founder and former president of Northrop Aircraft, Inc., was elected as a member of the board of directors of the Garrett Corp. Northrop, who retired from the presidency of Northrop Aircraft, Inc., in 1952, has been associated with the Garrett Corp. in a consultant capacity.

**RICHARD W. SELLWOOD** has joined the **Motor Transportation Magazine** as assistant publisher. In this position he oversees the business end of that truck publication. He had been advertising manager for **Go Magazine** in Los Angeles.

**DAVID M. LITTLE** has joined the Connor Lumber & Land Co. as plant manager of the Underwood Veneer Division. Underwood Veneer is located in Wausau, Wis. He had been chief industrial engineer for Roddis Plywood Corp. of Marshfield, Wis.

**FRANK L. SCHWARTZ**, professor of mechanical engineering at the University of Michigan, will provide a one-week intensive course in gas turbines and free piston engines at the University, June 13-17.

The course will cover centrifugal and axial compressors, radial inflow and axial turbines, high temperature metals, combustion, fuels, performance, stress analysis, thermodynamics of free piston engines, and free piston engine problems.

**HORACE E. MEAD** is now serving as service manager for the El Paso White Truck Sales Co. Before the purchase of the Autocar Co. by the White Truck Co. and closing of the Autocar Sales & Service branch at Dallas, he was district service manager in the Dallas branch.

**WILLIAM P. KALB** has taken a position with Bassick Co., Bridgeport, Conn., as sales engineer. He had served as secretary of the Lorr Laboratories, Inc., of Paterson, N. J.

**GEORGE KALON** is now associated with Lockheed Aircraft Corp., Burbank, Calif., as materials and process engineer. His duties include development and improvement of metallic and non-metallic materials and allied processing for commercial and military aircraft.

He had served in the same position with Turbo Products, Inc., of Pacoima, Calif.

**MARTIN J. POGGI** is district manager in the new Northwest district office of the Cook Electric Co. of Chicago, Ill. He was formerly installation engineer with Airsupply Co. Division of Garrett Corp.

Poggi

Clapper

**HOMER W. CLAPPER**, president of Bergen Wire Rope, a subsidiary of Reeves Soundcraft Corp., has been elected an executive vice-president of Soundcraft in charge of the Bergen Division.

**JAMES F. SULLIVAN** is now with Lifson & Sullivan Co., consulting engineers, Dallas, Texas, as engineer and analyst. He is concerned with economic operations analysis, management controls, and mechanical design and development. He had been general manager for Troyerbilt, Inc., of Albion, Ind.

**JOHN V. MOTTO** has taken the position of staff engineer with Harley Earl, Inc. of Centerline, Mich., with whom he will serve in design engineering and follow-up on company "appearance" product designs. He has been junior engineer for Fisher Body Engineering Division of General Motors Corp. in Detroit.

**H. J. ARNOLD**, who has been associated with Crucible Steel Co. of America as stainless steel specialist in the Cleveland plant, is now supervisor of stainless bar and wire sales in Pittsburgh, Pa.

**OSCAR L. BARD**, president of Michigan Tool Co., has been elected to the recently enlarged board of directors of Ex-Cell-O Corp. Ex-Cell-O recently acquired the Michigan Tool Co., which operates three plants in Michigan, and a subsidiary, Colonial Tool Co., in Windsor, Canada.

**DONALD C. HAYS** is now senior design engineer with Lockheed Aircraft Corp. in Palmsdale, Calif. In this position he will serve as group engineer in charge of all structures including landing gear on the two prototype YC 130 airplanes that are now undergoing flight test at Palmsdale.

**CHARLES F. BACON** has entered the United States Air Force as aircraft maintenance officer at Hill Air Force Base, Ogden, Utah. He had been an engine tester with International Harvester Co., Melrose Park, Ill.

As aircraft maintenance officer, he will have supervision of aircraft repair and will be in charge of the electrical, fabric, paint, welding, instrument, prop and hydraulics shops.

**WILLIAM M. SANFORD** has become assistant chief engineer—Boat Division of the Chris-Craft Corp. He had been supervisor of quality control and inspection. As assistant chief engineer he is chiefly concerned with research and development, but also serves in liaison with production engineering.

**DONALD F. DAVIS** has joined Central Steel & Wire Co., Chicago, as metallurgist. He had served with Salisbury Axle Works in Fort Wayne, Ind., as chief metallurgist.

In his position with Central Steel, Davis will serve in metallurgical sales, convey metallurgical information on request, and investigate metallurgical problems.

**EDWARD D. ROLLERT** has been appointed general manager of General Motors Corp. Harrison Radiator Division at Lockport, N. Y. He has been manager of the Buick-Oldsmobile-Pontiac Assembly Division plant at Kansas City, Kan., since 1951.

Harrison Radiator Division manufactures radiators, defrosters, heaters, thermostats and air conditioning systems for automotive applications. It also produces heat exchangers for aviation, marine, automotive and industrial uses, and is engaged in defense production.

**PRIMO L. PINOTTI** has taken a position with the Standard Oil Co. of California as product engineer. He had been research engineer with California Research Corp.

Pinotti is secretary of SAE Northern California Section.

**LEONARD A. CORN** has taken a position with Studebaker-Packard of Canada, Ltd., as chief inspector. He had served in that position with Reo Motors, Ltd., of Toronto, Ont., Canada.

**DAVID A. STODDART,** who had been an engineer with Thompson Products, Inc., is now quality control engineer with the Ford Division of Ford Motor Co. He is with the Technical Services Section, Quality Control Department, Lavonia, Mich.

**SEMON E. KNUDSEN** has been appointed general manager of the Detroit Diesel Engine Division of General Motors Corp. Knudsen goes to Detroit Diesel from GM's Allison Division, where he has been manufacturing manager for aircraft engine operations since 1954.

**ELWOOD C. BOLLES** has become assistant division manager of National Automotive Fibres, Inc. of Findlay, Ohio. He had been an engineer at the Detroit plant of that company.

**A. WALTER NEUMANN** is now director of maintenance and purchasing for the Willett Co. in Chicago. He had been director of maintenance.

Neumann was SAE Chicago Section's vice-chairman of Transportation & Maintenance Activity in 1951-52.

**PHILIP M. KLAUBER** has been named chief administrative engineer of Solar Aircraft Co.'s San Diego plant. He has been director of public relations for Solar since 1951. Solar's engineering division was recently formed by combination of the design engineering and development engineering divisions.

**BARRETT B. RUSSELL** has joined the Petroleum Chemicals Division of E. I. du Pont de Nemours & Co., Inc., of Tulsa, Okla., as assistant manager of the Mid-Continent region. He had been with the Petroleum Chemicals Division in Wilmington, Del., as additives coordinator.

**LEONARD AINSLEY** has transtransferred to Austin Motor Co., Ltd. from Morris Commercial Cars, Ltd., where he was project engineer. He will now serve in the Austin Experimental & Road Test Department (Commercial), Longbridge, Birmingham, England.

**STEPHEN J. BARNEY** is now associated with the Montreal, Que. branch of Bell Telephone Co of Canada, as vehicles office supervisor. He will be assisting the vehicles superintendent and supervising the office. He had been supervisor of vehicles.

**JESS W. GARDNER** is now on special assignment with the Chicago Tribune as flight engineer and mechanic. In this assignment, Gardner is concerned with the maintenance of a Convair 340 for the Chicago Tribune. He had previously been senior mechanic with American Air Lines, Inc. in Los Angeles.

**VICTOR H. BERNARDI,** formerly chief, Special Equipment Technical Unit, Field Service Division, Office, Chief of Ordnance, has been transferred to the staff of the director, Ordnance & Transport Equipment; Office, Assistant Secretary of Defense (Applications Engineering) in the Pentagon, Washington, D. C.

**ROBERT C. LANDESMAN,** formerly production engineer for Allison Division of General Motors Corp., has taken a position as manufacturing engineer with Aviation Gas Turbine Division of Westinghouse Electric Co.

**HARLAN H. DAVIS** is now manufacturers' representative, Harlan H. Davis, sales engineering organization in Naperville, Ill. He was Chicago manager for Rogers Publishing Co.

**WERNER W. BERGER** has moved to the General Motors Proving Ground, where he serves as vehicle development engineer in the Chevrolet Central Office Engineering Department. His work entails development engineering on passenger and commercial vehicle bodies and sheet metal. He had been with the Chevrolet Motor Division in Indianapolis as senior project engineer.

**EUGENE A. BRUHA,** who had been serving as automotive service engineer with the Tennessee Valley Authority, is now associated with Gateway Transportation Co., La Crosse, Wis., in the same position.

**LLOYD LOWERY** is now service superintendent for Petrous Service Stations in Honolulu, Hawaii. He had been employed with E. E. Black, Ltd., of Honolulu.

# Obituaries

### E. O. HOLMGRAIN

E. O. Holmgrain, chief engineer with Jay Madsen Equipment Co., Inc., Bath, N. Y., died Feb. 6.

After attending Augustana College, Rock Island, Ill. from 1907–09, Holmgrain became chief draftsman with Velie Motor Corp. in Moline, Ill. He later served as chief engineer and vice-president for the O. E. Szekely Corp. of Moline.

In 1929 he joined La France Republic Corp. as chief engineer concerned with motor truck design. He joined Ford Motor Truck Co. in 1932 as experimental engineer. He moved to Federal Motor Truck Co. in 1936 and remained with that company as experimental engineer until the time of his death.

### AUGUST S. DUESENBERG

August S. Duesenberg, 75 years old, one of the two famous brothers who built automobile engines that made history on the highways and set speed marks on the race track, died Feb. 16. Death was attributed to a heart attack. Duesenberg had suffered from heart disease for the last eight years.

Born in Lippe, Germany, he had been a resident of Indianapolis since 1921. Even before he moved there, however, the name of Duesenberg had been made a by-word at the Indianapolis Speedway by the performance of the race cars built by Duesenberg and his brother, the late Frederick S. Duesenberg. In 1922 the first seven places were won by Duesenberg-motored speedsters.

In the passenger car field, too, the brother team built an automobile whose horsepower was not surpassed until this year's modern, production-line models.

### EMORY DE NADOR

Emory De Nador, automotive engineer with the Engineering Laboratories, Ford Motor Co., Dearborn, Mich., has recently died. He was born in Sept., 1897 in Szekszard, Hungary.

De Nador received his education in Europe, attending Vienna Polytechnicum, Technical University—Zurich, and earning degrees of mechanical engineering and electrical engineering from the Universities of Budapest and Vienna in 1922. He also attended Joseph Technical University. He held membership in the Verein Deutscher Ingenieure and the Society of Engineers in Hungary.

He served with several firms in Austria and Hungary as draftsman and designer before coming to the United States to serve as designer in 1924 for Cleveland Automatic Machine Co. In 1927 he joined Ford Motor Co. as an engine designer and has served with Ford since that time, except for four years with Atlas Supply Co.

### JOHN C. THRASHER

John C. Thrasher, consultant with Joseph H. Marks Co., Detroit, died Jan. 30. He had joined Joseph Marks Co. in early January.

Thrasher was born at New London, Iowa and attended the University of Detroit, enrolled as an SAE Student Member from 1928–1930. He was a member of the Engineering Society of Detroit.

He became associated with Ford Motor Co. in 1950, taking the position of division general manager in the Manufacturing Division in Dearborn, Mich. Previous to his term with Ford, Thrasher had served in various positions from machinist to vice-president with companies such as McCord Corp., Studebaker Corp., Chrysler Motor Corp., Thompson Products, Inc. and Michigan Steel Tube Products Co.

### SAMUEL GILLESPIE

Samuel Gillespie, former president and general manager of Kingsley Mfg. Co., Ltd., Toronto, Ont., Can., died recently. He was born in Billings Bridge, Ont., Can. in July, 1875.

Gillespie started work in 1902 on the Locomobile and Stanley Steamers and helped Prof. Victor Emerson in designing cams and enlarging valves in Buffalo. He later put set springs made from kinked clock springs behind the piston rings of a two-cylinder Ford, also a two-cylinder Rambler, which gave noticeable results by increasing their power.

On the side, at this time, Gillespie secured several patents on a domestic refrigerating machine. 1920 brought the opening of a small shop making various articles of a fine engineering nature. The shop switched over to war work, making small parts for planes and anti-aircraft guns, as well as range finders and other optical work. In 1943, he became superintendent of the Kingsley Mfg. Co., of which he was president at the time of his death.

### THOMAS E. COON

Thomas E. Coon, project engineer in the Aircraft Engine Division of Studebaker-Packard Co., died Jan. 15. He was 30.

While attending the University of Detroit, Coon was employed during the summers as metallurgist's assistant for Packard Motor Car Co., Inc., and junior engineer for Swift Mfg. Co., Inc. He also served in the U. S. Army in ordnance automotive maintenance from 1943 to 1946. During 1947–48 he was assistant instructor in engineering drafting classes at the University of Detroit. He received his B.M.E. from the University in 1951.

After graduating, Coon joined Detroit Arsenal, Centerline, Mich. as project engineer. He served at the Arsenal until 1954, when he became associated with the Aircraft Engine Division of Packard Motor Car Co., now Studebaker-Packard Corp.

### CHARLES H. CRAWLEY

Charles H. Crawley, chief project engineer of the Weatherhead Co., Cleveland, died recently. He was born in Birkenhead, England in April, 1899.

Crawley had been employed at the Weatherhead Co. since 1927, when he joined the firm as engineer in charge of product design. He became chief project engineer of the plant in 1945 and served the company in that position until the time of his death.

### KENNETH A. HARMON

Kenneth A. Harmon, Wico Electric Co. president until Feb. 12, died suddenly on that date at his home in Longmeadow, Mass. He was 51 years old. Harmon was elected Wico president and general manager in January, 1945, after ten years' service as vice-president in Charge of Engineering. He was named to the board of directors in 1936. Prior to joining Wico in 1927, he held engineering positions with Cadillac Division of General Motors Corp., Rolls Royce, Ltd., and American Bosch Corp.

Harmon was widely recognized and respected for his engineering prominence in application to the design and manufacture of magnetos, the principal electrical product of the Wico Co. The engineering phase in magneto production at Wico remained his primary interest throughout his regime as president of the company. He was credited with many unique and helpful ideas and the engineering perfection of them made it possible for the company to provide its output for new uses of magnetos. During the war he served in numerous instances as expert consultant on problems relating to magneto use in many instances outside the work undertaken at his own company.

### H. D. NEIGHBORS

H. D. Neighbors, president of Air Brakes & Controls, Inc., died in December, 1954. He was 56 years of age.

Neighbors had been president of Air Brakes & Controls since Feb., 1942. His duties had included executive duties as well as general operating of heavy duty commercial brake service stations.

Previous to his service with Air Brakes & Controls, Neighbors was a representative for Bendix-Westinghouse Automotive Air Brake Co., selling, servicing and promoting Bendix-Westinghouse air brakes throughout the Southeastern section of the United States. He also spent several years of service and instruction work on air brake systems on U. S. Army vehicles.

### ARTHUR F. MILBRATH

Arthur F. Milbrath, 75, former vice-president and chief engineer of the Wisconsin Motor Corp., West Allis, died of a heart ailment at his home in February.

He retired last October after almost a half century of continuous service with the company. For 46 years he was vice-president and chief engineer of the firm and had designed all engines produced by it. He was recognized in engineering and power equipment circles as a leader in design and development of internal combustion engines. The Stutz Bearcat, a widely known sportscar of the early 1920's, was powered by an engine Milbrath designed. Other old time cars with his engines included the Kissel, Case and Cutting.

Milbrath was a member of SAE since 1910. Other affiliations included the American Society of Mechanical Engineers, the Wisconsin Club, the Blue Mound Golf and Country Club, the Milwaukee City Club, the Men's Sketch Club, and Kilbourn Masonic Lodge.

# from the Sections

## Buffalo

Field Editor
D. I. Hall
Jan. 18

**A GRADUAL TRYOUT OF AUTOMATION IS ADVOCATED** by General Electric Co. At first it would comprise a relatively small part of a tooling budget. Then, as experience was gained that would indicate the worth and application of automation to the particular goods being manufactured, increasingly large expenditures would follow.

This was stated by P. H. Alspach as members and guests of the Buffalo Section were treated to a symposium on automation. Guest speakers included P. H. Alspach, manager of manufacturing development, General Electric Co.; Herbert A. Franke, manager of automation, Buffalo Stamping Plant of the Ford Motor Co.; and E. Kaweckie, Hautau Engineering Co. Presiding was Frederick H. Thomas, professor at the University of Buffalo.

Franke stressed the **remarkable safety features** that automation could incur and stated that safety was one of the prime features designed into the automation equipment used at the Ford Stamping Plant in Buffalo. Another feature stressed by Franke was the stability of quality that could be maintained. Franke illustrated his portion of the discussion with a film illustrating the forming and assembly of the automobile floor plan thru automation.

Kaweckie approached the subject of automation from a slightly different viewpoint than did Alspach and Franke. He pointed out the advantages that could be gained thru the more efficient design of the machinery doing the work rather than emphasizing automation from machine to machine. He illustrated his part of the discussion with cleverly projected sketches showing how thoughtful design of a machine for turning jet engine housings resulted in a production capacity equal to that formerly achieved only thru the use of thirty standard machines.

## Baltimore

Field Editor
H. T. Cline
Feb. 10

**THE SIGNIFICANCE OF THE PAN-AMERICAN ROAD RACE FOR THE AUTOMOTIVE CUSTOMER** was brought out by Joseph R. Gillette of the Lincoln-Mercury Division of the Ford Motor Co. This was one of the many points of his paper which has been presented at many Section meetings during the past year.

While it is impossible for any customer to impose the abnormal demands of the Pan-American Road

**Milwaukee Feb. 4**

**SUBSTITUTING FOR LILLIAN GILBRETH,** who was hospitalized before the meeting, were (left to right) J. R. Gillette of Ford Motor Co., who presented the story of the Mexican Pan-American Road Race; Vern Houle of Ford, who accompanied Gillette; and Wilbur Dykhuizen of the Aluminum Co. of America, who provided a film on zinc and aluminum die casting.

**Philadelphia Mar. 10**

**PIASECKI ENGINEERS,** active in Section work, were hosts to SAE President C. G. A. Rosen on his visit to the Piasecki Helicopter Corp. plant at Morton, Pa. on Mar. 10 (see story on p. 85). President Rosen had spoken the previous evening at the Philadelphia Section meeting. There, Section Chairman J. J. Mikita presided and introduced the honored guest.

Race on his personal car, it is gratifying for him to know of the **extra reserve** built into his car as a whole and all of its component parts.

## Philadelphia

Field Editor
Gordon T. Seng
Feb. 9

**FORTY YEARS OF TEAMWORK** between the bus operator and bus manufacturer have been culminated in the Greyhound Scenicruiser, a two level intercity bus, according to Floyd A. Franklin, coach engineer, GMC Truck and Coach Division.

Franklin pointed up some of the advance features of this modern miracle of the highway.

For passenger comfort there are roomier seats, proper ventilation and air-conditioning, greater visibility for enjoying the scenery, practical washroom facilities and many other features.

Among the many engineering and design features is the air suspension system which replaces the conventional metal springs; the absence of a chassis frame, commanding special considerations to be given the body sides, which serve as main longitudinal load carrying members.

Unique, too, is the disposal of the wash basin water through the engine exhaust system, Franklin said.

The vehicle is powered by two GM two-cycle, 150 hp four-cylinder diesel engines which drive the bus and all accessories. The engines are so accessible that they can be changed while the coach is on normal scheduled turn-around time.

A two-speed clutch and three-speed transmission permits the driver to select the correct gear for any road or load condition.

Approximately 200 of an initial order for 500 of these Scenicruisers are in operation on main line routes all over the country, Franklin said, and he strongly recommended that everyone try at some time this new experience in highway travel.

Mar. 9

**DESIGN CONCEPTS DISCARDED** long ago often reappear years later when new materials or changed markets make them ripe for economic development, SAE President C. G. A. Rosen proved while "Thumbing Through an Engineer's Notebook" at the Engineer's Club on March 9. His chalk talk touched the old and the new, the changes and the reasons for them in many diesel engine areas.

Section Chairman J. J. Mikita, director of du Pont's petroleum laboratory in Wilmington was chairman for the evening. He praised "The SAE Story", the recently published history of the Society, saying: "I read it through in one sitting." He also summarized interestingly the technical contributions of the nine men to whom—with President Rosen's cooperation—he presented certificates marking 25 and 35 years of membership in the Society.

The President's visit to Philadelphia Section was marked by his personal tour of the Piasecki Helicopter plants, the largest of which is at Morton, Pa. Piasecki men prominent in SAE activity were his hosts. (See photograph on opposite page.) Among them were the following SAE members who appear in the photograph: Vincent J. Zardus, senior group engineer, who is Philadelphia Section vice-chairman for aircraft; Elliot Daland, engineering advisor, who had just received his 25-year membership certificate; and Bruno D'Angelo, designer, who is Piasecki plant respresentative for the Section's membership committee. Welcoming the SAE President to Piasecki also were Frank K. McMahon, military liaison administrator and the 1953 Wright Brothers Award winners D. N. Meyers and Z. Ciolkosz. Accompanying President Rosen was Philadelphia Section Vice-Chairman George J. Liddell, Sun Oil Co.

## Milwaukee

Field Editor
F. B. Esty
Feb. 14

**AN INDICATION OF THE EXTREME MILEAGE POSSIBLE** under normal operations without anything more than ordinary maintenance is the Mexican Pan-American Road Race, probably the toughest automotive race in the world. It has rough road surface, high mountains, altitudes from practically sea level to over 10,000 ft, and long straight stretches where top speeds can be attained and held for relatively long periods. This is the only place where cars can be tested on an actual highway nearly 2,000 miles long at practically full throttle continuously.

While it is impossible for any customer to impose such abnormal demands on his personal car, it is gratifying for him to know of the extra reserve built into his car as a whole and all of its major component parts. Likewise, it is gratifying to the producer, for this may be considered another accelerated test verifying all those run previous to production release.

This picture of the race was presented to the Section by J. R. Gillette of the Lincoln-Mercury Division of Ford Motor Co.

## Washington

Field Editor
R. J. Auburn
Jan. 20

**AN EDITOR'S VIEW** on the automobiles of 1955 was presented at this Jan. 20 Section meeting. Joseph Geschelin addressed the meeting with an enlightening report on "Trends in Automobiles For 1955." Geschelin, Detroit editor for **Automotive Industry**,

**Oregon Jan. 13**

**JOINING IN THE SECTION JANUARY MEETING** were five past-chairmen and the current chairman of Oregon Section, and (center) speaker for the evening W. F. Driver of Vickers, Inc., Division of Sperry Corp. The chairmen are (left to right) Edward A. Haas 1951–52, C. A. Dillinger 1952–53, Clarence Bear 1953–54, T. E. Bokemeier 1954–55, Earl Marks 1941–42, and C. H. Lewis 1950–51.

**Detroit Feb. 7**

**POINTING OUT DETAILS** of the Scenicruiser suspension system to Section Vice-Chairman for Truck and Bus Activity Frank W. Hudson (right) is the speaker, Floyd A. Franklin of GMC's Truck and Coach Division.

**Motor Age**, and **Commercial Car Journal**, described the results of his recent survey of 1955 models.

The overhead valve V-8 engine type, which dominates the engine field with over **37 different varieties**, continues to be improved and developed for **more power** and **higher torque** at low speeds. To achieve the higher torques at low speed, displacements are increasing, and short-stroke piston design with bore-stroke ratio of 1.25 is being widely used.

The power race evident from trends shown by 1955 models is largely based upon advantages in safety resulting from high performance. With greater acceleration at both low and high speeds, it is possible to escape from hazardous highway situations.

1955 models are featuring more glass, lower hoods, tubeless tires, simplified air-conditioning, torsion bar suspensions, anti-fouling spark plugs, and many other improvements.

Geschelin's talk was followed by lively questioning from members and guests on future trends and developments in the automotive industry.

## Detroit

Field Editor
W. F. Sherman
Feb. 7

**THE NINE-YEAR DEPRECIATION CYCLE** used by the operators indicates the long service life required in motor coaches, according to Floyd A. Franklin, coach engineer, GMC Truck and Coach Division, who was speaker at the Detroit Section meeting on Feb. 7. In evolving new vehicles, therefore, each feature must be one that is time-tested. Many of the basic items can be traced back through years of development and service operation.

Franklin, introduced by Section Vice-Chairman of the Truck and Bus Activity, Frank W. Hudson, showed interesting pictures of early highway transport vehicles. This led up to discussion of the modern two-level Scenicruiser. This vehicle, with air spring suspension, power steering, power brakes and air conditioning, operates at 40,000 lb weight on long distance cross country trips.

375 cu ft of storage space underneath the main passenger compartment provides facility for carrying luggage of passengers and for freight hauling, which is a developing phase of coach operation.

The fluted side panels of these modern coaches are load-carrying members to help hold down vehicle weight. Service requirements have made it necessary to provide for ease of engine change so the complete unit can be removed and replaced with another without keeping the vehicle out of service long. Some of these coaches have accumulated more than 2,000,000 miles and the first major overhaul usually isn't needed until more than one-quarter million miles have been covered. Tire and brake life on the newer vehicles is not yet established, but 65,000 miles on the trailing axle of the tandem axles is expected and 100,000 miles is anticipated on the front tires.

The suspension system provides for level ride with the air supply coming from the compressor in the vehicle. Interestingly, no air is lost on the road due to the operation of the suspension devices, but air is vented when the vehicle is being loaded. Front tires have been blown out at 60 mph without the driver knowing that they have lost pressure.

## Dayton

Field Editor
C. P. Kelley
Feb. 17

**STYLING DEMANDS FOR MASS PRODUCTION** are important factors, since styling must suit the majority of customers. This was brought out by G. T. Christiansen, administrative assistant in the Styling Section of General Motors Corp., who talked on the subject of "Styling For Today's Cars."

Christiansen indicated that good design pays off in today's market in that a person buys because something looks good.

The Styling Section at General Motors dates back to 1927. It has since grown to approximately 750 people including **designers, engineers, clay modelers, model makers** and **plastic modelers**. Each GM division has individual studios for building and presenting new models. All layouts, detail drawings and actual scale models are full scale and give a true picture of every detail.

Christiansen presented a series of slides showing the procedure that was followed in designing and building the 1955 Buick Wildcat #3, which was shown for the first time in the New York show. These were pictures of the model in various stages of the development and included the wood frame, the clay model, casting of the plastic parts and the completely finished model as it was presented at the show.

He stated that the philosophy of the Styling Section is to work on a model until the last minute. It is their job to sell the design to the car division and make changes if necessary. There were nine designs presented for a Pontiac grille before final approval.

A film titled "Look of Things," showing what is in the mind of the stylist, was an interesting addition to an interesting program.

This was the Golden Anniversary Meeting of Dayton Section and Frank E. Carroll, SAE vice-president for Aircraft Powerplant Activity, extended greetings from SAE President C. G. A. Rosen.

## Mid-Continent

Field Editor
L. D. Reis
Feb. 18

**DRAWING THE USUAL RECORD ATTENDANCE**, this time at Mid-Continent Section meeting, was

**New England Mar. 1**

**INTRODUCING SPEAKER** Donald S. Crow (right) New York Division, Cummins Diesel Corp., are (left) Section Diesel Vice-Chairman Joseph R. Comeau and (center) Section Chairman Gustav Heiber.

**Southern California Feb. 14**

**WELCOMING DR. ULRICH C. LUFT** (right), speaker from Lovelace Foundation, are Section Vice-Chairman for Aircraft Activity C. F. Thomas (left) and Section Chairman Marvin Russell (center).

**Central Illinois Feb. 21**

**DISTINGUISHED GUESTS** of Section Chairman Randall Roman (right) at this Golden Anniversary meeting were SAE President C. G. A. Rosen (center) and SAE Secretary and General Manager John A. C. Warner (left).

Joseph R. Gillette of the Lincoln-Mercury Division of Ford Motor Co., who told the story of the Pan-American Road Race. The talk was well illustrated with slides.

In addition to covering the specifications of entries, he also described preparations and incidents that occurred during the running of the race. The climax of the program was a color movie of the 1954 "Run For the River."

## New England

Field Editor
G. T. Brown
Mar. 1

**A TERRITORIAL INCREASE FOR NEW ENGLAND SECTION** was announced at this meeting by Section Membership Committee Chairman Richard Lawrence. Counties in southern Maine and New Hampshire have become part of New England Section.

Donald S. Crow, assistant regional manager of the New York office of Cummins Diesel Motive Power Corp., was the main speaker of the evening. He maintained that the design and operation of the PT fuel system fulfill the many requirements and design criteria laid down by the Cummins company. Among these requirements Crow listed **good acceleration and deceleration characteristics, good idling characteristics, long, trouble free service, interchangeability of major components on all models of Cummins Diesels,** and **low manufacturing cost.**

Acceptance of the new pump is indicated by the fact that not a single operator returned a PT system when the field test was closed in May.

## Central Illinois

Field Editors
Y. M. Miller
E. E. Hanson
Feb. 21

**THE FUTURE OF OUR SOCIETY RESTS WITH THE CREATIVE ABILITY OF ENGINEERS,** not with the rich natural resources we once possessed. SAE President C. G. A. Rosen spoke at the Section Golden Anniversary meeting on the subject, "In Quest Of Creativeness".

President Rosen believes that we are in the age of deliberate creativeness in which scientific advances must be made by self-generated creativity. He listed the following steps necessary to deliberate creativity:

1. Reading material and analysing the problem.
2. Sketching preliminary designs.
3. Constructing models to resolve complexities.
4. Conducting lab. experiments for new discoveries.
5. Promoting verbal exchange and committee discussion.
6. Testing opposites to determine correct results.
7. Explaining limits of possibilities mentally.

During the meeting, 35-year Membership Certificates were presented to John T. Liggett, Allis-Chalmers Mfg. Co., and Samuel W. Gray, Decatur Club, Decatur, Ill. 25-year Membership Certificates were presented to J. Milton Davies, Caterpillar Tractor Co., Harold A. Fletcher, Caterpillar Tractor Co., H. S. Eberhard, Caterpillar Tractor Co., and Arthur Townhill, Alloy Engineering & Casting Co.

## Southern California

Field Editor
W. E. Achor
Jan. 24

**A NEW MICROMETRIC ADJUSTING NUT** makes it easy to adjust wheel bearings correctly. Ellis W. Templin, president of Micro-Nut Co., Inc., which makes the device, described it in a paper "Micro-Nut, A Means For Obtaining Correct Wheel Bearing Adjustment."

Templin states that the Micro-Nut has been designed to render **comfort** and **safety** in steering and add measurably to the economical operation of the modern vehicle, whether it be passenger car, truck, trailer, or tractor. The Micro-Nut is a safety device and **compensates for its original installation price in a short time.**

Previous to this talk, a panel discussion was held on the Care and Maintenance of Wheel Bearings. Four experts in the field were present to give pointers on this important subject.

H. V. Fleming, district manager of the Industrial Division of the Timken Roller Bearing Co., spoke on bearing failures and of the necessity for proper lubricants and proper solvents to clean bearings.

The second panel speaker was V. E. Weiss, automotive engineer of the Lubrication Division of Standard Oil Co. of Calif. Weiss spoke of the importance of proper lubrication for wheel bearings.

The proper installation of seals is vital to bearing protection. M. K. Gebert, chief research engineer of the National Motor Bearing Co., Inc. stressed this in his discussion of oil seals in bearings to protect and retain lubricants.

P. F. Schlageter was the fourth member of the panel. As western representative of the Mechanex Corp., Schlageter spoke on the care of wheel bearings and oil seals, and recommended fluid lubricants rather than thick lubricants.

Field Editor
W. E. Achor
Feb. 14

**HUMAN COMPETENCE UNDER CONDITIONS WHICH HAVE NO PRECEDENT IN THE HISTORY OF MANKIND** has become an important consideration to members of the engineering field. Wider and more precise knowledge of physiological limits are required to furnish optimal specifications for

the design and construction of aircraft and safety devices.

The study of **high impacts** which develop not only in crash but also in ejection, windblast, drag and parachute opening shock in emergency escape has become more urgent and is being accomplished with new instruments for the quantitative measurement of forces.

In anticipation of flight to the limits of the atmosphere, the possible influence of **cosmic radiation** on biological specimens is under study by means of balloons and rocket missiles. The **state of weightlessness,** as predicted to occur in a vehicle following an orbit in which gravitation and inertia cancel each other has been simulated for brief periods of time. Finally, the feasibility of manned flight with nuclear-powered aircraft presents a challenge which can be met only by the combined endeavors of engineering and medical sciences.

These interesting facts were expressed by Dr. Ulrich C. Luft, head of the Physiology Department of Lovelace Foundation, Albuquerque, N. M.

Seated at the speaker's table and commenting on the paper entitled, "Man's Reactions to High Altitude and Space Flight," were Dr. Charles Barron, Lockheed Aircraft Corp.; Bill Bridgman, Douglas Aircraft Corp., Inc.; Vincent Blockley, North American Aviation, Inc.; Col. John Stapp, U. S. Air Force; Anthony LeVier, Lockheed Aircraft Corp.; and Dr. John R. Poppen of the Aero-Medical Associations.

—Submitted by R. S. Orchard

## Western Michigan

Field Editor
W. C. Chaffee
Feb. 15

**POWER FOR SPACE SHIPS** will undoubtedly be obtained from clusters of small ramjet engines according to Magnus Von Braun, chief liaison engineer, Redstone Arsenal in his speech delivered in Muskegon on Feb. 15. This conclusion is based on the advantages of control and repair as compared to one large engine. A liquid propellant will most likely be used for the fuel.

Von Braun gave an interesting and timely lecture on air breathing and rocket engines used to provide power for guided missiles and space ships. The theory of operation and characteristics of the various engines and their fuels were explained in detail.

The ram-jet engine with a liquid propellant seems to be the best bet for space travel. It is the simplest engine yet devised. The use of liquid propellants permits the design of an engine with a constant size of combustion chamber. Solid fuels would make the engine dependent upon the combustion chamber size since they cannot be pumped and the combustion chamber is the only place they can be stored. The use of liquid fuels also permits the engine to obtain non-interceptable speeds. The cooling system of these engines will be of the regenerative type and the performance of the engines is measured in seconds or by specific impulses.

The use of atomic energy as a fuel for space ships still needs the solution of the problem of a suitable heat carrier and the shielding of the deadly radiation.

## Texas Gulf Coast

Field Editor
G. W. Putney
Feb. 11

**A 7.17 to 1 DIFFERENTIAL GEAR RATIO IS THE HIGHEST ALLOWED** for successful operation with single reduction drives. For ratios higher than 7.17 to 1, the double reduction axle should be used. Tandems using the inter axle differential drive tend to run at lower temperatures than single reduction drives.

"Application and Operation of Tandem Axles" was the subject presented by J. R. Bartholomew, assistant sales manager for the Axle Division of Eaton Mfg. Co. Using slides to supplement his talk, Bartholomew discussed the Eaton tandem drive axle with power divider and differential locking device on the forward driving axle.

It was pointed out that the locking device is used only when extra traction is required, as excessive use of the lock device increases tire wear.

From the operation standpoint, **proper lubricant, regular oil changes,** and **regular inspections for leaks are most important.** Any changes in the sound of axles should be investigated immediately.

## Alberta

Field Editor
S. J. Frith
Jan. 20

**A TWIN-ENGINED MODEL OF THE NORTH KING,** a new type of off-highway transporter being developed in Calgary by North King Equipment (Canada), Ltd., has been completed and is now undergoing tests. Leslie Cahan, manager of the firm, told these facts to Alberta Group members and guests.

The North King is a **four-wheel-drive vehicle equipped with tracks** for traveling in rough country. The tracks are worn over rubber-tired wheels, and may be removed for ordinary driving conditions.

The vehicle, designed primarily for use in the North country, incorporates three new principles. **It is articulated,** that is "hinged" in the center, to facilitate turning and for general maneuverability; **the wheels are mounted on a walking beam** which permits them to follow the contour of the ground without "pitching" the cab; and **steering is affected** by turning the entire front section of the vehicle **with a pair of hydraulic rams.**

The new model, in addition to the motor in the forward power unit, has a second engine mounted in the rear load-carrying section of the vehicle. This new model has proved capable of climbing a

grade with a maximum slope of 42 degrees.

Tests have not been completed and a number of "bugs" have still to be worked out, said Cahan, but results so far appeared satisfactory.

—Submitted by W. Moore

## Cincinnati

Field Editor
Owen Negangard
Feb. 28

**NUCLEAR PROPULSION** as the power source of the future was discussed before the members and guests of the Cincinnati Section by J. W. Darley of the General Electric Aircraft Nuclear Propulsion Project.

Darley's experience in the nuclear field qualifies him as a very interesting and informative speaker on the atom and its use as a source of power in the future. He stated that due to certain restrictions and conditions, atomic propulsion for motor vehicles was not in the foreseeable future, but extensive work would be continued to be utilized for power for other forms of transportation, both air and water.

F. E. Carroll, Jr., SAE Vice-President representing Aircraft Powerplant Activity and chief engineer of United Aircraft Products, Inc., represented the SAE New York Office. He extended greetings and in a short address covered the 50th Anniversary of SAE, the progress of the past fifty years, and the purpose and work that lies ahead for the organization.

## Salt Lake

Field Editor
C. W. Dunbar
Feb. 8

**AN ANNUAL SAVINGS IN GASOLINE OF APPROXIMATELY 400,000,000 GALLONS A YEAR** is represented in a gain of only 1% in the efficiency of our gasoline-powered vehicle engines. This indicates the importance of efficiency gains obtained through increased compression ratio. These interesting facts arose from the talk by Rollin E. Gish on "Trends in Gasoline Quality and Commercial Engine Design."

Gish, assistant manager of engine research of the Ethyl Corp. Research Laboratories at Detroit, Mich., pointed out that although there was a feeling expressed in some quarters that the design of commercial vehicle engines has not taken as much advantage of the improvement in fuel antiknock quality as the design of passenger car engines, the facts were otherwise. Actually, percentage improvements in truck and coach engines since 1935 compare most favorably with the passenger cars. Average displacement has remained practically constant at 400 cu in. while brake horsepower has increased about 50%. A factor creating this gain has been the introduction of some of the newer passenger car engines modified for truck use in the smaller engine category. In the larger engine sizes, the gains have come through improved volumetric efficiency, increased compression ratio and a small increase in engine speed.

On future developments, he stated that it is safe to say that the 1960 commercial vehicles will have greater specific outputs, use less fuel per brake horsepower-hour and have durability equal to or better than that obtained with the best of today's designs. It is probable the 1960 commercial engine will have:

1—At least 0.5 brake horsepower per cu in. of displacement.
2—A compression ratio in the range of 7.5–8.0.
3—Less weight both on a lbs per horsepower and lbs per unit of displacement basis. A weight range from 3½ to 5 lbs per horsepower appears likely.

The result will be a higher ratio of payload to tare weight, improved economy, greater flexibility and more horsepower per dollar of investment.

## Southern New England

Field Editor
A. D. Nichols
Mar. 2

**NICKEL PLATING CAN BE DIVIDED INTO TWO GENERAL CLASSIFICATIONS**, decorative plating, used on items which must be lustrous and have sales appeal, and for engineering applications where the product must have corrosion and erosion resistance, said Dr. Dodd S. Carr, assistant director of electrochemical research, Bart Mfg. Corp. In decorative plating a coating of .001 is considered heavy, while the plate on a mechanical part may be as heavy as .040–.050. There are several means of applying nickel plate:

1. **Chemical deposition** where a steel part is immersed in a bath. The plating process stops when the part is covered and the thickness is about 30 millionths.

2. **Chemical reduction** or electroless nickel plate. This process is 20–30% efficient, the acidity is critical, the nickel is impure and non-magnetic, but the coating is uniform and can be several thousandths thick. It can be used for parts of intricate shapes and also for inside of pipes and other vessels.

3. **Electro-chemical reduction** where the part, immersed in a solution, is the cathode and a nickel bar is the anode.

4. **Mechanical cladding** where nickel sheet is applied directly to the steel sheet. The part is then heated to fuse the nickel to the steel and rolled to the desired thickness.

5. **Metal spray** where the molten nickel is sprayed on the part. Electro-forming is a method used to form a part of intricate shape. A fusible mandrel is plated to the desired thickness and then melted, leaving the nickel part. Nickel plated sheets for corrosive liquids are produced up to 84 in. wide and 20 ft long.

# *Golden Anniversary Flavor . . .*

## . . . added to Aeronautic Forum Program scheduled for April 21 in New York.

G. F. CHAPLINE (right) Sponsor, and A. B. Hegner, General Chairman, of the 1955 SAE Aeronautic Production Forum, examine a banner with the SAE Golden Anniversary emblem. They advise that the "forward look" adopted by the Society as its half-century celebration theme, has been injected into the program planning for the seven panels Forum.

The Forum will take place on the 21st of this month, at the Hotel McAlpin, in New York City. It is being held in conjunction with the 1955 SAE Golden Anniversary National Aeronautic Meeting, which will be held on the three days preceding the Forum, at the Hotel Statler.

# *YOU'LL* . . . be interested to know that . . .

A GROUP OF STUDENTS from Ohio Northern University journeyed up from Ada, O. to Detroit to spend a day at the SAE Golden Anniversary Annual Meeting. They were accompanied by Prof. H. M. Jacklin, head of the school's mechanical engineering department.

HERBERT HAPPERSBERG, Brockway Motor Co., Inc., has been appointed SAE representative at the 25th Annual Safety Convention and Exposition of the Greater New York Safety Council, Hotel Statler, New York City, April 11–15, 1955.

W. M. HOLADAY, Socony-Vacuum Oil Co., Inc., has been appointed to serve as SAE representative on the National Committee for the United States for the Fourth World Petroleum Congress, Rome, Italy, June 6–15, 1955.

STUDENT BRANCH CHARTERS have been authorized at Yale University, New Haven, Conn., and Southwestern Louisiana Institute, Lafayette, La.

Guided by Prof. C. W. Phelps, faculty advisor from Yale School of Engineering, the SAE club at Yale has boosted its membership over the required 25 and through its activities, such as the tour of the Tarrytown Chevrolet and Fisher Body plants, has proven itself a continuing and successful organization.

Likewise, with the help of faculty advisor Dr. P. A. Chieri, Department of Mechanical Engineering, the club at Southwestern Louisiana Institute has gained the required membership and the endorsement of the engineering faculty at the Institute.

8,527,895 AERONAUTICAL MATERIAL SPECIFICATIONS have been issued from SAE Headquarters since 1939. That's more than 2,000 per working day for over 15 years. The complete set of 659 specifications can be purchased for $40.60.

The March 1, 1955 edition contains 67 new and revised AMS and an index. Price: $7.05 (1 to 40 sets); $5.75 (41–80 sets); $3.75 (over 81 sets).

SAE ATLANTA AND MOHAWK-HUDSON GROUPS have achieved Section status. The progress of the Groups, the quality of their meetings, and their membership growth have satisfied the Council that the Groups have fulfilled the requirements for Section status.

Atlanta Section, organized as a Group in 1949, has been leading the country in percentage growth this year.

Mohawk-Hudson Section, whose activities center in the Albany, Troy, and Schenectady area of New York, was organized as a group in 1942. It encompasses the Student Branch at Rensselaer Polytechnic Institute.

SAE HAS FOUND NEED for policies and programs for the whole area of recognitions and awards. As a result, the SAE Council has established a SAE Recognitions and Awards Committee. Members have been appointed as follows:

B. B. Bachman, Chairman
D. P. Barnard
G. A. Delaney
W. S. James
William Littlewood
Walter F. Rockwell
H. E. Chesebrough (as Chairman, Meetings Committee)
M. A. Thorne (as Chairman, Public Relations Committee)
T. L. Swansen (as Chairman, Publications Committee)

This committee has been established to serve the following functions:

1. To establish objectives for SAE recognitions and awards.
2. To develop a positive program of SAE recognitions and awards that will best attain these objectives.
3. To develop requirements or conditions against which new proposals on SAE recognition projects or awards can be measured and evaluated before acceptance.

THE SAE COUNCIL has revised Rule 3 of the Horning Memorial Rules of Award. The revised version reads as follows (the underlined words have been added; the scored words have been deleted):

3. All papers having not more than two authors on the subjects indicated above which are presented before Society or Section meetings during each calendar year ~~will automatically~~ shall be eligible to receive consideration by the Board of Award.

This revision becomes effective in 1956.

# 1955 SAE GOLDEN ANNIVERSARY NATIONAL MEETINGS . . .

April 18-21

Aeronautic Meeting,
Aeronautic Production Forum,
and Aircraft Engineering
Display, Hotel Statler and
McAlpin Hotel, New York, N. Y.

June 12-17

Summer Meeting
Chalfonte-Haddon Hall,
Atlantic City, N. J.

August 15-17

West Coast Meeting
Hotel Multnomah, Portland,
Ore.

September 12-15

Tractor Meeting and
Production Forum
Hotel Schroeder, Milwaukee,
Wis.

October 11-15

Aeronautic Meeting
Aircraft Production Forum,
and Aircraft Engineering
Display
Hotel Statler, Los Angeles, Calif.

October 31-November 2

Transportation Meeting
The Chase, St. Louis, Mo.

November 2-4

Diesel Engine Meeting
The Chase, St. Louis, Mo.

November 9-10

Fuels and Lubricants Meeting
The Bellevue-Stratford
Philadelphia, Pa.

# 1956 SAE National Meeting

January 9-13

Annual Meeting
The Sheraton-Cadillac Hotel
and Hotel Statler, Detroit,
Mich.

# SHOCK AND VIBRATION . . .

## . . . Investigators of SAE Committee S-8 Participate in Golden Anniversary Aero Meeting in New York

CHALK up another notch on the yardstick of progress being made by SAE Committee S-8, Aircraft Shock and Vibration Isolation, toward its goal.

THE GOAL: To develop an integrated fund of knowledge on shock and vibration as a sound engineering basis for protecting fragile and sensitive devices.

THE PROGRESS: Sponsorship of a two-session Symposium on shock and vibration at the SAE Golden Anniversary National Aeronautic Meeting in New York this month.

The two technical sessions to be held at the Hotel Statler this month on April 18 will each include four papers. The Symposium is to be chairmanned by W. L. Hardy, of Foster D. Snell Co., who is also Chairman of Committee S-8. Chairmen of the two sessions are H. J. Wenborn of General Electric, and E. H. Jones of Bell Telephone Laboratories.

Committee S-8's participation in this Meeting is the second such endeavor it has undertaken. Last Fall the Committee sponsored similar sessions at the 1954 SAE National Aeronautic Meeting in Los Angeles. The success of those sessions as well as the interest in the subject generated there stimulated the development of the two sessions this month in New York.

Highlights of the information growing out of the Los Angeles sessions were printed in the article "Stamping a Package 'Fragile' Is Not Enough," in the March, 1955 issue of SAE Journal, pp. 53–57.

The marriage of the Committee's technical program with other information-disseminating tools of the Society (such as National meetings and publications), notes Chairman Hardy, helps achieve two things:

1. It helps the Committee get the participation of a large number of engineers from different fields. This furnishes the Committee with a broader base of data, researches, and experiences upon which to build its integrated package of facts.

2. It helps spread the benefits from sound engineering principles to more engineers and companies. Costly damage to expensive equipment from inadequate protection is a serious problem in many areas.

At present the Committee has five active subcommittees probing information on various facets of the problem. The areas under study by these groups are: (1) basic information; (2) test procedures; (3) service conditions; (4) packaging materials and methods; and (5) codification and reports.

Participants in the symposium on Shock and Vibration Isolation sponsored by SAE Committee S-8 in Los Angeles last October, at the SAE National Aeronautic Meeting. W. L. Hardy, Chairman of Committee S-8, is seated at left.

# M. M. Steele Joins Staff Of SAE Aeronautics Department

M. M. Steele

MEL M. STEELE joined the staff of the Society on March 1 as an engineer assigned to handle staff work on many of the SAE technical committees concerned with aircraft engines, propellers, and other aircraft equipment.

Steele comes to the SAE staff from the Alloy Engineering and Casting Co. He served there as an engineer responsible for purchasing and operations. Previously he was a purchasing and contracting officer for the Air Force at Wright-Patterson Air Force Base.

He has degrees from Ohio University in both industrial engineering and business administration.

The SAE committees Steele has taken over were formerly staffed by William R. Beckerle, who recently resigned from the Society's employ to join Weston Hydraulics, Ltd.

# Aero Materials Specs Reviewed by Industry

DRAFTS of twenty-four SAE Aeronautical Materials Specifications are currently being circulated to industry for comment and criticism by the SAE Aeronautical Materials Specifications Division.

Eight specifications have been approved recently by the SAE Technical Board. Five specifications have been cancelled.

Copies of all of these specifications are available for review from the SAE Aeronautical Department, 29 West 39 Street, New York 18, N. Y.

**The specifications under review are:**

- AMS 3204D—Synthetic Rubber, Low Temperature Resistant (25-35);
- AMS 3205D—Synthetic Rubber, Low Temperature Resistant (45-55);
- AMS 3355—Silicone Rubber Lubricating Oil and Compression Set Resistant (45-55);
- AMS 3356—Silicone Rubber, Lubricating Oil and Compression Set Resistant (55-65);
- AMS 3357—Silicone Rubber, Lubricating Oil and Compression Set Resistant (65-75);
- AMS 3590—Plastic Sheet, Copper Faced, Paper Reinforced Phenolformaldehyde;
- AMS 3601—Plastic Sheet, Copper Faced, Glass Fabric Reinforced Epoxy Resin;
- AMS 3730—Potting Compound—Foamed Epoxy Type Amine Hardened;
- AMS 4035D—Aluminum Alloy Sheet and Plate, 4.5Cu-1.5Mg-0.6Mn (2024-0);
- AMS 4037D—Aluminum Alloy Sheet and Plate, 4.5Cu-1.5Mg-0.6Mn (2024-T3);
- AMS 4086E—Aluminum Alloy Tubing, Hydraulic, 4.5Cu-1.5Mg-0.5Mn (2024-T3);
- AMS 4087B—Aluminum Alloy Tubing, Seamless, 4.5Cu-1.5Mg-0.6Mn (2024-0);
- AMS 4088D—Aluminum Alloy Tubing, 4.5Cu-1.5Mg-0.5Mn (2024-T3);
- AMS 4908A—Titanium Alloy Sheet, 8Mn, Annealed—110,000 psi Yield;
- AMS 7496B—Rings, Flash Welded, Carbon and Low Alloy Steels;
- AMS —— Titanium Tubing, Annealed —50,000 psi Yield;
- AMS —— Aluminum Sheet-Laminated, Edge Bonded;
- AMS —— Aluminum Sheet-Laminated, Surface Bonded;
- AMS —— Spot Welding of Commercially Pure Titanium;
- AMS —— Alloy Strip, Iron Base—5.2Cr-42Ni-2.3Ti-0.5Al Solution Treated;
- AMS —— Alloy Strip, Iron Base—5.2Cr-42Ni-2.3Ti-0.5Al Cold Rolled, 10% Reduction;
- AMS —— Alloy Strip, Iron Base—5.2Cr-42Ni-2.3Ti-0.5Al Cold Rolled, 50% Reduction;
- AMS —— Aluminum Alloy Forgings, 4.3Zn-3.3Mg-0.6Cu 0.18Cr (7079-T6);
- AMS —— Titanium Alloy, 2Cr-2Fe-2Mo, Annealed 120,000 psi Yield;

**The approved specifications are:**

- AMS 3334, 3335, 3336, 3338—Silicone Rubber, Extreme Low Temperature Resistant;
- AMS 4051, 4052—Aluminum Alloy Sheet and Plate, Aluminum Alloy Clad;
- AMS 4091, 4093—Aluminum Alloy Tubing, Hydraulic;
- AMS 4092—Aluminum Alloy Tubing;
- AMS 4155, 4158—Aluminum Alloy Extrusions;
- AMS 6275A—Steel;
- AMS 6407—Steel;
- AMS 6436—Steel Sheet and Strip, Low Alloy Heat Resistant;

**The cancelled specifications are:**

- AMS 5535—Alloy Sheet and Strip, Corrosion and Heat Resistant, Cobalt Base;
- AMS 5752—Alloy, Corrosion and Heat Resistant, Nickel Base;
- AMS 2671A—Copper Furnace Brazing, Corrosion and Heat Resistant Steels and Alloys;
- AMS 3197E, 3198E, 3199E—Synthetic Rubber Sponge, Chloroprene Type;
- AMS 5673—Steel Wire, Corrosion Resistant.

# Carbide Cutting Tools Group Formed by ISTC

A GROUP is being formed to develop a classification, definitions, and possibly specifications for carbide cutting tools.

The group will be a joint division of the SAE Iron and Steel Technical Committee and the SAE Nonferrous Metals Committee. ISTC's interest stems from the fact that, although the carbide tools are themselves nonferrous, they are used extensively for cutting ferrous parts.

Idea for the project came out of informal discussions at the 1954 SAE National Production Meeting in Chicago.

Having accepted invitations to participate, these men will form the nucleus of the new group: G. F. Bush, Ford; C. G. Chambers, General Motors; W. E. Day, Jr. Mack Mfg.; A. S. Jameson, International Harvester; G. C. Riegel, Caterpillar Tractor; Bruce Wright, Buick; and H. H. ZurBurg, Chrysler.

# Nordberg Radials Have No Master Rod

Based on paper by

A. W. SCHAPER
Nordberg Mfg. Co.

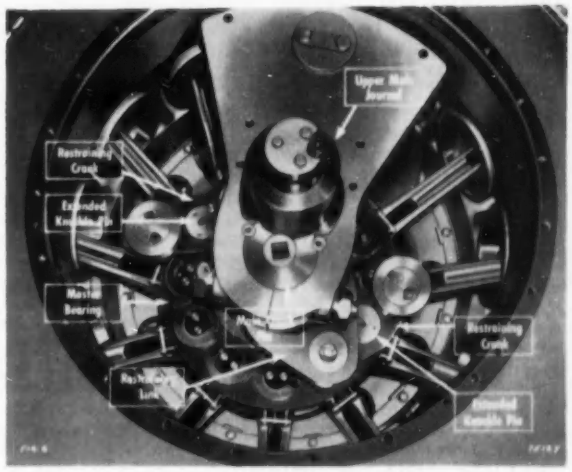



Fig. 1—Plan view of upper crank and restraining mechanism of the Nordberg radial engine revealed by removal of crankcase cover.

TWO basic designs of restraining mechanism are employed on the Nordberg radial two-cycle engine to supersede the master rod restraint provided in propeller aircraft engines. On the 11-cylinder model the master crankpin bearing is prevented from rotating by use of a planetary gear train which connects the master bearing gear to the stationary crankcase cover.

The gear train consists of four gears. The stationary gear is fastened to the underside of the crankcase cover and is connected to the gear teeth of the master gear through a unit comprising the upper pinion, driveshaft, and drive gear. The gear train transmits no power, its sole purpose being to prevent rotation of the master gear.

In the 12-cylinder model a restraining linkage replaces the planetary gear. Two opposite connecting rods are used as master connecting rods and are always held at 180 deg from each other. These rods are rigidly connected through special longer knuckle pins to their corresponding restraining cranks which are above the master bearing. The pins of the restraining cranks are tied together by a restraining link which has an oval hole in the middle to allow the main crankshaft pin to revolve without touching the link. On the opposite end of the restraining cranks are counterbalances. In this manner, two opposite pistons, corresponding connecting rods, special knuckle pins with restraining cranks, and the restraining link form a kinematically constrained linkage which has its reactions at the cylinder walls as the master bearing tends to rotate. This linkage prevents the master bearing from rotation but does not restrain the piston motion of the main parts of the engine mechanism. The restraining mechanism is shown in Fig. 1. (Paper, "The Nordberg Radial Two-Cycle Engine" was presented at SAE Milwaukee Section, May 7, 1954. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers).

# Seven Precautions For Cold Room Safety

Based on paper by

P. W. ESPENSCHADE
Mechanical Engineering Dept., ERDL

COLD-CLIMATE experiments and the operation of low-temperature chambers involve hazards. The Aero Medical Laboratory has compiled rules for personnel and the Air Proving Ground Command advises on precautions with respect to carbon monoxide resulting from engine or heater exhaust gas in the test space. In addition, here are seven precautions gleaned from experience:

**Fire**—Spilled fuel (on hot surfaces), backfiring from engine manifolds and heaters, and electrical short-circuits are always a possibility. Fire consumes a lot of oxygen and the operator may be quickly affected. Disconnection of battery ground straps before equipment servicing, pre-start observations of exhaust lines for clogging and fuel puddling, and checks of heater burners before igniting are key steps in safety.

**Drains**—Spillage of fuel, oil, antifreeze, hydraulic fluid, and the like are frequent. The presence of moisture adds complication and makes footing dangerously slippery if a sump is not available for drainage.

**Observation and Alarms**—The buddy system should always be used for operators, and their work should be done under the direct and continuing view of an outside attendant. Trip devices for alarms and emergency lights should be readily accessible along the walls, easy to find through smoke or fog, and capable of actuation by foot, arm, or general body contact.

**Personal Hygiene**—Dirty skin and clothes are cold. Fabric penetration by fuel or oil may result in loss of insulating property, particularly with arctic clothing and gloves. Volatile petroleum products are dangerous for exposed flesh under low temperature conditions.

**Noxious fumes**—Gas detection for carbon monoxide does not indicate other troublesome sources. Burn-off of lacquers, paints, and enamels may create hazardous atmospheres. If not thoroughly consumed and exhausted, fractions of priming fluid may have an anesthetic effect.

**Vacuum**—The mechanics of exhausting test chambers are sometimes complicated. Failure to insure an abundant air supply may result in dangerous conditions and lead to atmospheric pressure on doors so great as to prevent escape.

**Shut-Down Devices**—Arrangements should be made for shut-down of engines or disconnection of electrical machinery by positive controls from outside the chamber.

(Paper "Low Temperature Engine Testing and Facilities" was presented at SAE National Diesel Engine Meeting, Cleveland, Oct. 26, 1954. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Please Turn Page

## Transistors Improve Flight Control System

Based on paper by

JAMES B. TREACY
Bendix Aviation Corp.

THE transistor will bring about basic changes in the philosophies of design and performance of automatic flight controls which developed during the vacuum tube era.

When properly used, existing transistors are impressively more reliable than the vacuum tubes they supplanted. Design and manufacturing techniques have improved enormously within the past 18 months and no one familiar with transistor application would dare define the ultimate limit of its use. The ones we possess have the characteristic of working better and better the colder they are, hence their use may be anticipated in some of the coldest spots of the earth.

Bendix has already built and delivered a system in which transistors replace all vacuum tubes and is flying a development model of a commercial system similarly altered. The reduction of size, weight and power required, plus the circuit simplifications which are possible, can result in very worthwhile, practical equipment. (Paper, "Automatic Flight Control" was presented at SAE Montreal Section, Montreal, Oct. 18, 1954. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

## Turbojet Temperature Requires Close Control

Based on paper by

GEORGE R. DESI
and
CYRUS F. WOOD
Aviation Gas Turbine Division,
Westinghouse Electric Corp.

THE pilot of a military aircraft may need the last ounce of thrust available from the engine, but not at the risk of serious damage to the engine. Thus, engine variables, especially turbine outlet temperature, must be regulated with great accuracy. On a modern afterburning turbojet use of an automatic temperature control alone makes possible safe operation of the engine at its maximum thrust output under all flight conditions.

The mere presence of a temperature control is not sufficient. To be valuable the control must be absolutely reliable. And for added safety the control should act only as a "trim". By this means, the range of control may be limited so that the pilot will always have effective control over the outlet temperature.

The first requirement for proper design of a temperature control is a knowledge of the physical conditions under which engine and control system must operate. The designer must also take into account engine noise characteristices and the human element involved in the assembly and servicing of the controls. Several procedures have been developed to prevent trouble from engine noise and human error and their success in application has been proven in field service. (Paper, "Reliability of Temperature Controls" was presented at SAE Los Angeles Aeronautic Meeting, Oct. 8, 1954. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

## Pneumatic Components Show Faults in Flight

Based on paper by

GEORGE A. LEMKE
Convair Division, General Dynamics Corp.

OPERATING experience has proved pneumatic components to be functionally sound, but malfunctions of accessories and related components have caused expensive flight delays and in some instances have aborted flights.

This malfunctioning has occurred with two low pressure systems—one, a combination accessory drive and refrigerator turbine used in interceptor aircraft; the other, a gas turbine motor used to drive an alternator in a large flying boat.

Investigation has revealed the following troubles:

1—Several cases of accessory detail design deficiencies.
2—Lack of quality control on accessory components on the GTM.
3—Unsatisfactory routing of wires and plumbing.
4—Improper installation and inspection of fuel system components by operator.
5—Improper operation of over-speed control switch.
6—Erratic operation of pressure regulator and shut-off valve.

To get fast corrective action both Boeing and Convair use a "Malfunction Report". Such a report should identify the trouble by number and provide a complete description of it. An investigation team should establish the cause and evaluate the results of the investigation. Responsibility should then be fixed and the necessary action taken to prevent a recurrence. (Paper, "Operational Experience — Pneumatic Components of Cabin Pressurization and Accessory Drive Systems" was presented at SAE Los Angeles Aeronautic Meeting, Oct. 8, 1954. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

## Synthetic Lubes Need More Development

Based on paper by

C. S. BRANDT
Convair Division, General Dynamics Corp.

OUR flight experience with synthetic lubricants is still relatively limited, yet we believe sufficient time has been accumulated to warrant drawing several conclusions:

1. A clean source of engine bleed air for cabin conditioning must be provided to prevent exposure to noxious or irritating contaminations.

2. Formation of noxious products is not confined to the particular characteristics of synthetic oils or to the operating conditions in the higher-powered engines. Any oil will decompose to form irritants when subject to pressure and temperature changes.

3. More information and experience is needed to evaluate fully the compatability of aircraft materials with synthetic oils. And since the problem is industry-wide, there should be coordination to prevent costly duplication of testing, man-hour waste and the like.

4. Continued operation of present engines and the introduction of new, higher-powered ones probably will require radical changes in synthetic oil characteristics. Problems incurred with the use of such new lubricants should be clearly defined and solutions ascertained prior to industry-wide adoption.

5. The MIL-L-7808 procurement specification is too broad. As written, it is possible to qualify a product markedly different from those now on the approved source list as regards effects on rubbers, paints and plastics are concerned. Information received

informally recently from an engine manufacturer indicates that this may have happened already. (Paper "Experience with Synthetic Lubricants in Aircraft Power Plants" was presented at SAE Los Angeles Aeronautic Meeting, Oct. 8, 1954. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

# Army Craves Mobility Swears by Helicopter

Based on paper by

**WILLIAM B. BUNKER,**

Transportation Corps, US Army Commandant, The Transportation School

DURING World War II an Army, such as General Patton's Third Army, had only 10 or 12 small Cub airplanes in its artillery units; today the typical field army has over 600 assigned aircraft, ranging from small 2-place fixed wing craft to large 40-passenger helicopter.

The helicopter as a concept has been completely adopted by the Army. Today's military training and planning considers its broad scale use essential in future combat. The machines, on the other hand, have a long way to go to be able to perform missions effectively and economically. Therefore, instead of being pushed by commercial advances the Army has turned pioneer without waiting for a demonstration.

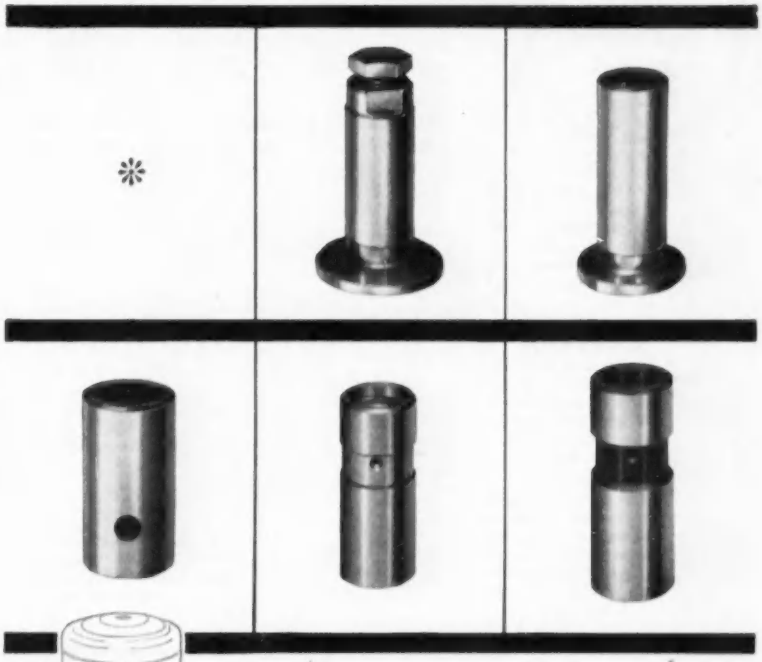
Of the three catagories of rotary wing craft—reconnaissance, utility, and cargo or transport—the last is receiving the major portion of the Army's research and procurement funds and effort. In the five-year program launched to build up the minimum helicopter force considered capable of supporting our current Army strength, we contemplate the procurement of 1000 cargo helicopters at a cost of more than a billion dollars. Such a program, in times of decreasing military budgets, indicates the confidence the Army staff places in this new development.

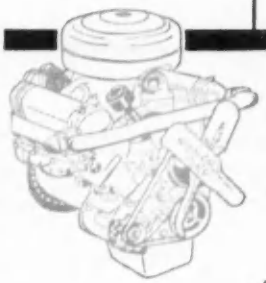
Major use of Army transport helicopters corresponds to the two branches of Army operation. They are employed in tactics and logistics. And one of the advantages of the helicopter lies in the ability of the same aircraft to perform both functions. Tactically, the use is to restore mobility of striking forces by eliminating their dependence on ground transportation. Modern concepts of warfare require wide dispersion of small units which can easily become isolated and surrounded. If these units can be readily reinforced or removed by helicopter, the psychological reluctance of troops to conduct this type of operation can be minimized.

## Big Transport Potential

It is in the field of logistics, however, that the transport helicopter has widest application. Tanks and rapid fire weapons, which are being used in ever increasing numbers, have tremendous appetites for fuel and ammunition. Even in the days of atomic weapons Army operations of necessity consist of large bodies of men and large amounts of equipment which must be moved and supported. The helicopter is used here to bring forward supplies and equipment in the area between the Army depots and the troops, usually a distance of 75 to 150 miles. In this area roads are usually damaged by combat action, frequently overloaded, and often clogged with refugees and civilian traffic, so that a truck is lucky

**JOHNSON** *tappets*





*keep pace with today's engines*

Continual experimentation and excellent manufacturing methods show a steady product improvement that make JOHNSON TAPPETS worthy of your consideration. Only proven materials, covering a range of steel, chilled iron, and various iron alloys are used in the manufacture of JOHNSON TAPPETS, providing greater strength, light weight and increased wear resistance. Serving the AUTOMOTIVE — AIRCRAFT — FARM — INDUSTRIAL — MARINE Industries.

*"tappets are our business"*

**JOHNSON JP PRODUCTS**

MUSKEGON, inc. MICHIGAN

to achieve an overall speed of 10 mph, while road and vehicle maintenance is tremendous.

It is the implications of atomic warfare that place the emphasis on the aerial truck capable of rapid support to our units at any point in the combat area. This means of movement, instantly available to the Army Commander, allows him to disperse his forces to minimize the effect of the enemy's attack and at the same time retain ability to concentrate support at the point of attack and to maintain support and control of his scattered forces. These problems can be met only by a vehicle which is independent of ground conditions, can overpass natural or artificial obstacles, and whose terminal facilities and rights-of-way may not be destroyed by bombardment.


PALNUT LOCK NUTS
Trademark

Slash Fastening Costs!

PALNUT—WASHER TYPE

For moldings, nameplates, medallions, ornaments, tail and parking lights, instruments, etc.

SPACER TYPE. Large clearance spans bosses of die cast parts or other protruding elements. Eliminates cup washer, lock-washer and nut.

The PALNUT Washer Type is a spring steel lock nut and flat washer in one piece. Replaces two, three, sometimes four separate pieces of hardware. Especially adapted to high speed application with hand or power tools. Many types and sizes.

GROUNDING TYPE. Depressed teeth in washer base cut through non-conductive coatings to electrically ground assemblies on tail and front parking lights.

TYPE D. Available in variety of washer base diameters. Large washer base spans large slots — spring resiliency eliminates stud breakage and dimpling of body stock. Keeps parts tight in service.

TYPE E. Machine screw sizes used on instruments, ammeters, electrical gauges and studs. Larger sizes for mounting air inlet and dash controls.

SEALER TYPE. Has sealing compound at base to keep out dust and water. This one part replaces sealer washer, flat washer, lock washer and nut.

PALNUTS—Regular Type
Apply on top of ordinary nuts to keep nut and bolt absolutely tight under severest vibration, on connecting rods, brake parts, housings, structural parts, etc. On light assemblies, used alone as self-locking nut.

PALNUT—Acorn Type
Used on glove compartments and wherever rough bolt ends must be covered.

PALNUT—Wing Type
Locks against vibration when finger tightened. Used on battery hold downs and air cleaners.

Write Detroit office for free samples and data

THE PALNUT COMPANY
70 Cordier St., Irvington 11, N. J.
Regional sales office:
726 West Eight Mile Road, Detroit 20, Mich. Tel. JOrdan 4-6087


## Tough Operating Conditions

To appreciate the problems of Army transport helicopters, full recognition must be given to their operating environment. In an active theater, with the line of combat continually moving, it is improbable that the helicopter unit will be able to secure an improved airfield, and the necessity for camouflage decreases this probability. The units will be operating continuously in dust and mud with few opportunities to improve the areas. To a large degree, therefore, the usefulness of the cargo helicopter depends on its ability to operate from completely unprepared areas without excessive maintenance. The supply of spare parts to combat equipment has always represented an extremely difficult problem, the solution to which is best found in designing equipment with minimum spare part requirements.

In modern mobile warfare all military personnel must be well trained for combat no matter what their "normal" occupation. Many skirmishes in Korea were fought by mechanics, signalmen and cooks and such instances will increase. Technical specialist training must be minimized if manpower, our most critical resource, is to be employed effectively. Military equipment, therefore, should be designed as far as possible so that it can be maintained and operated by average personnel with limited special training.

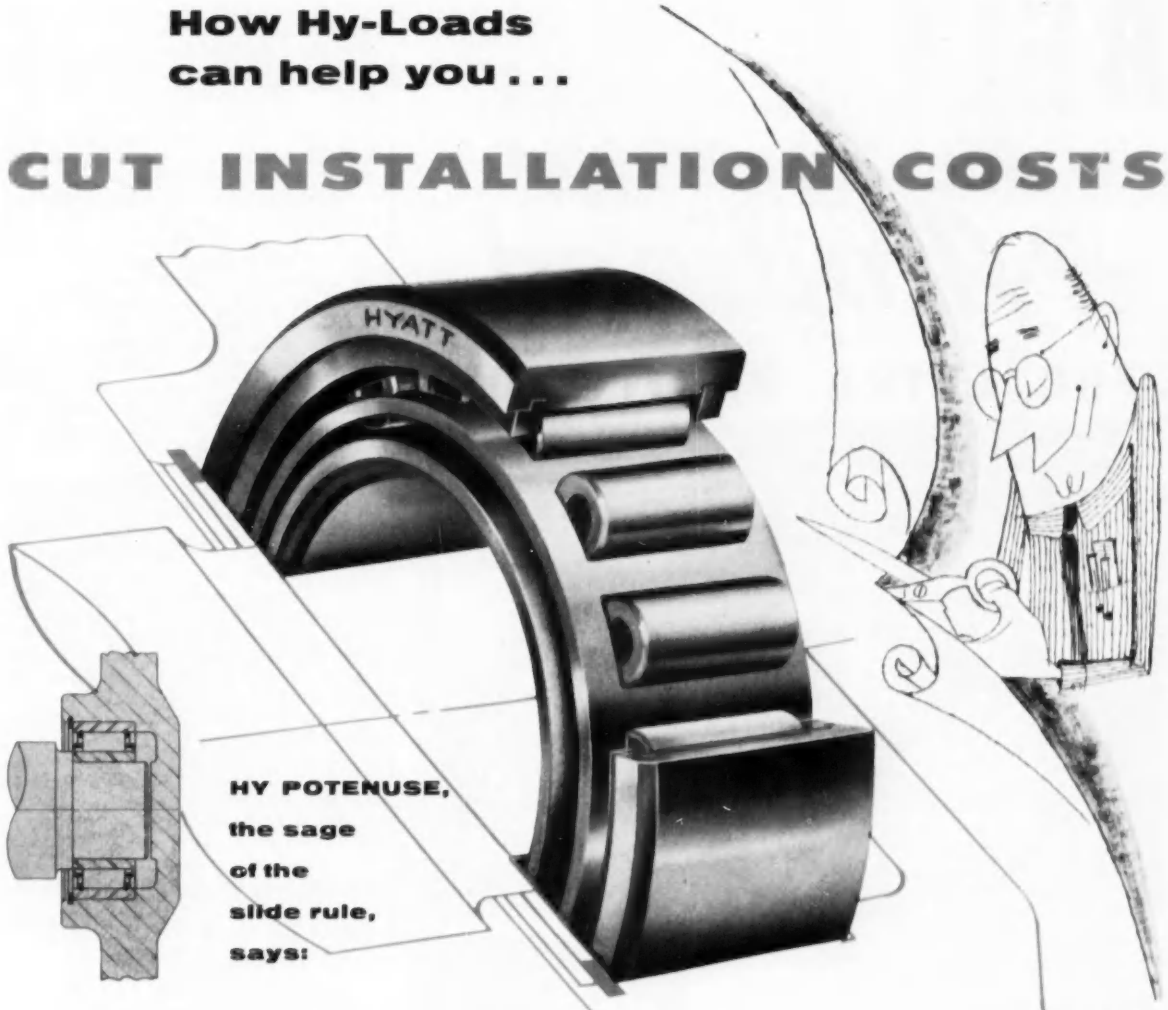
The characteristics of the Army cargo helicopter are dictated by its mission and employment. It must be dependable for participation in combat operation. It must be rugged to operate under the most difficult conditions of weather—in mud, sand, and snow. Delicate devices requiring ideal operating conditions are unsuitable however effective they may be theoretically. They must be simple and easy to maintain with average inducted troops operating under far from ideal conditions and with minimum facilities.

The problems of the helicopter are now primarily those of the mechanical engineer. Better engines, better transmissions, better solutions to the problems of vibration and fatigue are required. We have concentrated primarily on building faster and larger helicopters and have accepted the fact of mechanical immaturity. Today, more recognition is being given to the necessity for adequate powerplants. Our current design competition has specified a 750-hr minimum overhaul cycle for their transmissions, and progress is being made in licking problems of fatigue and vibration.

Today the helicopter requires the complete and constant attention of the pilots, and the rate of fatigue is extremely high. Solutions have been offered, primarily involving electronic and hydraulic devices to perform the pilot's function. But serious study

## How Hy-Loads can help you . . .

# CUT INSTALLATION COSTS




**You don't need a lot of extra "holding gimmicks" with HYATTS!**

YOUR COMPLETE LINE OF CYLINDRICAL ROLLER BEARINGS

Look at this speed reducer, for instance. The inner race of the HYATT Hy-Load is held on the shaft with a heavy press or shrink fit—*nothing more!* No money wasted for end clamps, threads, nuts, screws or washers. And brother, that rotating HYATT race will *never crack or come loose* come h - - - or high water. Know why?

HYATT races are made from low carbon alloy steel which, after carburizing, provides a *ductile core* and *case hardened operating surfaces*. That's why they'll take press fits and shock loads that would be suicide for the through-hardened steel used by other bearing makers. Naturally, it costs HYATT more to maintain the industry's finest heat-treating facilities that make this extra quality possible—*but it sure saves trouble and money for every HYATT user!* Hyatt Bearings Division, General Motors Corporation, Harrison, N. J.

# HYATT ROLLER BEARINGS

STRAIGHT BARREL TAPER

# BELL *Aircraft* CORPORATION

## HELICOPTERS ARE *Alodized*

WITH "ALODINE"®

## FOR EXTRA PROTECTION

Products of over a million flight hours, BELL Helicopters perform equally well in sub-zero and tropical temperatures, in mountainous areas or below sea level and over land or water. They can carry anything from a bottle of life-giving blood plasma to a quarter-ton of cargo.

BELL Helicopters have endurance! And, on aluminum components, "Alodine" provides greatly increased corrosion-resistance and lasting paint adhesion. Consistent results of 1200 hours or more salt spray exposure have been obtained, as compared with 250 hours maximum for anodized material under identical circumstances.

*If it's aluminum be sure it's Alodized*

Simplicity of the Alodizing process, the short time cycle, the elimination of precise racking of material to be processed, and the absence of expensive and bulky heating and current-producing equipment have substantially reduced operational costs.

*Pioneering Research and Development Since 1914*

**AMERICAN CHEMICAL PAINT COMPANY**

CHEMICALS ACP PROCESSES

**General Offices: Ambler, Penna.**

CHEMICALS ACP PROCESSES

**Detroit, Michigan** **Niles, California** **Windsor, Ontario**


should be given to the possibility of developing through redesign or new concepts a simplified control system and to increasing stability of cargo helicopters while retaining essential maneuverability and performance. The introduction of delicate, expensive, and difficult-to-maintain devices should come only as a last resort.

Generally speaking, the Army has discounted the importance of speed because the time required to load and unload cargo and personnel has made air speed one of the less important characteristics. We have felt that it was far too easy for aeronautical engineers to be distracted into a pursuit for higher speeds instead of keeping their noses to the grindstone to produce stronger and better components. Speed, achieved without sacrifice of other considerations, is of course a valuable asset.

The situation challenges the engineering profession to produce the machines our concepts require. It is as insufficient for engineers to say that improvements will accrue automatically with experience, or to excuse shortcomings on the grounds of immaturity as it would be for the military to excuse non-adoption of the machine because current prototypes and concepts had not been battle tested. The period between prototype and design and the effective machine must be shortened. Once World War III begins there will be little or no time to refine developments. (Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

### Based on discussion . . .


**James R. Bright**

Graduate School of Business Administration, Harvard University


We have taken the ordinary motor truck, made it sturdy enough to go anywhere and to handle cargo, and completely neglected the question of how many man-hours had to go into getting things on and off of it! Approximately the same thing has happened with marine cargo ships. To a large extent it exists with commercial air cargo planes.

The challenge before the transportation industry is this: Why can't we create a military helicopter in which the ability to load and discharge cargo is put first.

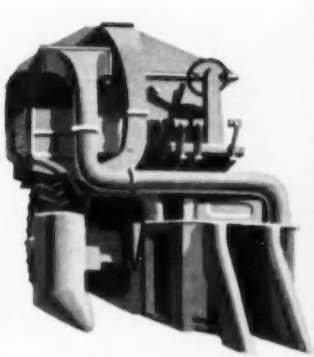
It is important to separate the cargo-carrying element from the flying element. There is no point in tying up the transporting medium while loading. Such a system will reduce greatly the turnaround time for the helicopter. It will permit loading when the craft is not there. It will permit setting cargoes down in a desired location and taking off again in a matter of seconds. Then, the unloading of the giant box can take place anytime. We will not achieve the ultimate until we build a container that can be flown rather than a helicopter that carries cargo.

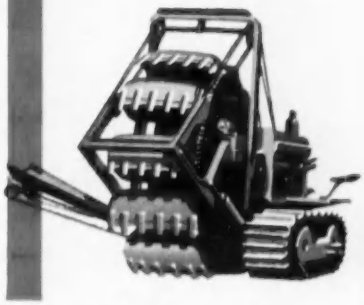
MAKE IT WEIGH LESS

N-A-X

HIGH-TENSILE STEEL

MAKE IT LAST LONGER





You can design light weight, longer life, and economy into your products by including N-A-X HIGH-TENSILE in your plans.

- It is 50% stronger than mild steel.
- It is considerably more resistant to corrosion.
- It has greater paint adhesion with less undercoat corrosion.
- It has high fatigue life with great toughness.
- It has greater resistance to abrasion or wear.
- It is readily and easily welded by any process.
- It polishes to a high lustre at minimum cost.

And with all these physical advantages over mild carbon steel —it can be cold formed as readily into the most difficult shaped stamping.

When you next start to redesign, get the facts on N-A-X HIGH-TENSILE. It's produced by Great Lakes Steel—long recognized specialists in flat-rolled steel products.

N-A-X Alloy Division

GREAT LAKES STEEL CORPORATION

Ecorse, Detroit 29, Mich. • A Unit of

NATIONAL STEEL CORPORATION

## How To Control Roll In Supersonic Aircraft

Based on paper by

F. C. ALLEN
Douglas Aircraft Co., Inc.

THE high rate of roll in supersonic aircraft is unnecessary from a control viewpoint and undesirable from a structural viewpoint. The problem is how to prevent it.

One solution is to limit the rate of roll arbitrarily to the maximum required for maneuvering. This puts the responsibility for keeping within structural limits up to the pilot. It has the advantage of eliminating extra mechanical devices and results in a simpler machine. On the other hand, with a power-controlled system, full throw of the lateral control can be obtained with 30 lb of pilot effort or less. The pilot may inadvertently overstress the airplane when flying under strenuous conditions.

Another solution is to limit the roll to the physical limitations of the pilot. Here it must be remembered that both rolling acceleration and rolling velocity must be considered. High loads can be obtained in either the initial "abrupt displacement" phase of the maneuver or in the later "steady roll" phase. Both rolling acceleration and centrifugal force will produce unpleasant sensations for the pilot which, theoretically, can be used as a guide for regulating the severity of the maneuver. Rolling acceleration can be applied abruptly, hence there is some doubt that the pilot can react in time to prevent overloading. Research and statistical information are needed to clarify this point.

A third possibility lies in the use of automatically variable stops, automatic pressure regulators, or mechanical advantage changers. The added complexity is a serious factor to reckon with, and each designer must judge the course to be followed in his particular design. Such devices can be used to limit the sensitiveness of the control as well as to limit the loads and, therefore, would be desirable from the standpoint of flying qualities.

The signal for automatic limitation of control cannot be the centrifugal force caused by rolling velocity since the rolling acceleration at the start of the maneuver may produce equally high wing loads. Similarly, the rolling acceleration cannot be used since the rolling velocity may exceed the desired amount without necessarily developing critical rolling acceleration. A study indicates that at each Mach number there is a maximum aileron deflection that should not be exceeded. Successful automatic limitation, therefore, requires that maximum aileron throw be varied with Mach number. If this is done, both the rolling acceleration and the rolling velocity can be limited to values consistent with satisfactory wing weight.

A fourth and last solution is to use spoilers. Data indicates that spoilers have characteristics which will tend to alleviate the problem. Because of their adverse characteristics near the stall, spoilers cannot be used alone and are usually combined with flap-type ailerons. The adverse load characteristics of the flap-type system, therefore, will not be eliminated entirely by the use of spoilers. Additional data in the higher speed ranges are needed to investigate the combined system in detail. (Paper "Unsymmetrical Flight Loads Problems in Supersonic Aircraft" was presented at SAE Los Angeles Aeronautic Meeting, Oct. 8, 1954. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

SINCE 1907
"PARK"
THE SYMBOL FOR
QUALITY
IN
DIE FORGINGS
FROM VITAL AVIATION DROP FORGINGS
TO DIESEL CRANKSHAFTS
WEIGHING UP TO 4000 LBS.
THE PARK DROP FORGE CO.
E. 79th & GORDON PARK
CLEVELAND 3, OHIO

## French Turbojet Is Americanized

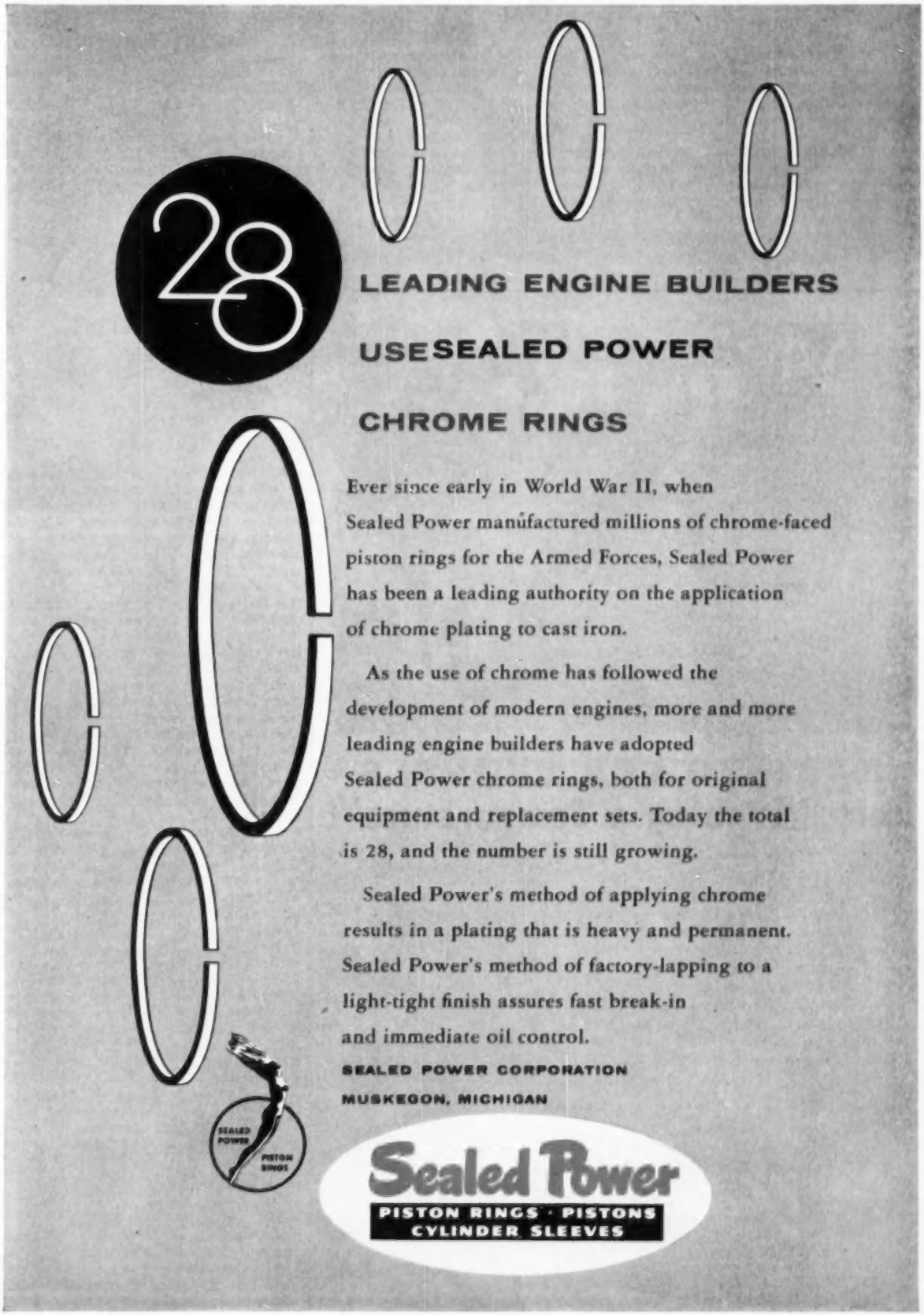
Based on paper by

J. C. SQUIERS
Continental Aviation and Engineering Corp.

THE American J-69 engine, sponsored by the Air Force, is based upon the French Marbore turbojet. In the process of Americanizing it, changes were held to a minimum and the aerothermodynamic features were kept identical so as not to jeopardize the excellent performance characteristics of the engine.

For some parts different materials were substituted to reduce content of scarce alloys. But materials were selected to give equivalent or better physical properties. Thus, for the turbine wheels a Nimonic 80-A alloy, high in nickel, was substituted for the still-more-critical cobalt-containing French alloy ATVS-7. For other hot parts of the engine, nickel and chromium alloys were selected which had the same composition as the French (Nimonic 75 and A-151-321).

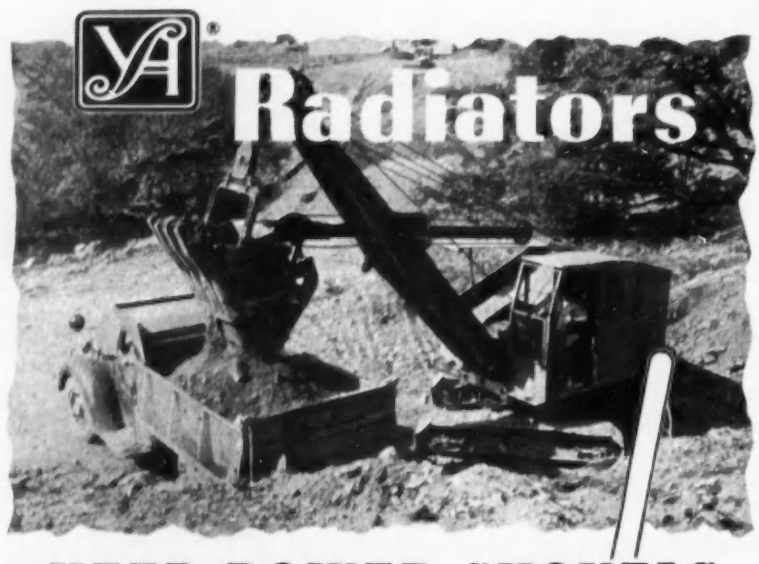
In general the selection of American


28
LEADING ENGINE BUILDERS
USE SEALED POWER
CHROME RINGS
Ever since early in World War II, when Sealed Power manufactured millions of chrome-faced piston rings for the Armed Forces, Sealed Power has been a leading authority on the application of chrome plating to cast iron.
As the use of chrome has followed the development of modern engines, more and more leading engine builders have adopted Sealed Power chrome rings, both for original equipment and replacement sets. Today the total is 28, and the number is still growing.
Sealed Power's method of applying chrome results in a plating that is heavy and permanent. Sealed Power's method of factory-lapping to a light-tight finish assures fast break-in and immediate oil control.
SEALED POWER CORPORATION
MUSKEGON, MICHIGAN
Sealed Power
PISTON RINGS · PISTONS
CYLINDER SLEEVES

material for structural parts such as shafts and gears was based upon the American practice of using steels with lower quantities of alloying elements consistent with serviceability—for example, 8740, 4140, 4130, and 8630. In most cases the American aluminum and magnesium alloys were identical in composition with those of the French. For the impeller we used 14ST aluminum forgings instead of the French 18ST because of wider experience with them.

Although the underlying philosophy was to maintain the design intact as far as possible, additions and design improvements were necessary to fulfill Air Force requirements. Major design modifications included a new accessory arrangement, the addition of torch ignitors, a new engine control system, and the use of American materials.

In general, the performance of the American version is about the same as its French antecedent. The increase in weight is accounted for by the additional accessory drives and the more elaborate fuel control system. (Paper "Small Turbojet for Trainer Aircraft" was presented at SAE Los Angeles Aeronautic Meeting, Oct. 8, 1954. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)


KEEP POWER SHOVELS from "Running a Temperature"!

DOING the rugged work of maintaining and grading roads such as this heavy-duty Power Shovel is called upon to handle day after day could easily make its power unit "run a temperature". But with dependable YA Radiator equipment for efficient cooling it steps right out whenever called upon. Perhaps you, too, are building equipment that could well use YA Radiators — write Yates-American for complete information.

California Representative: E. E. Richter & Son, Emeryville, Cal.

YA
Heat Transfer Products Division
Yates-American
BELOIT, WISCONSIN
BRANCH OFFICES: CHICAGO, ILLINOIS; HIGH POINT, NORTH CAROLINA; MEMPHIS, TENNESSEE; PORTLAND, OREGON


# Electronic Equipment Needs Unitizing

Based on paper by


**R. J. CARY**
Ryan Aeronautical Co.


UNITIZING of electronic equipment will be the most economically feasible answer to any great increase in military airborne equipment requirements. Each new aircraft will have its own peculiar electronic complement so that it will be feasible no longer to use a particular system in more than a few different types of aircraft without changing the equipment configuration.

Several basic types of configuration have been explored in recent years. The modular rack type of construction is an outstanding example. This configuration presupposes that nearly all the electronic equipment carried on the aircraft can be packaged in certain module dimensions. The module, or subassembly, package would be determined by the factors of size, weight, cost, complexity, reliability and maintenance.

The step to trans- and super-sonic aircraft will constitute a change of serious proportions. Eventually new techniques and ideas will be needed to overcome the problems associated with increasing complexity and more severe environment. To reach this goal will require electronics designers to work side by side with other kinds of engineers and designers. (Paper, "Aircraft Environment and Airborne Electronic Equipment Packaging" was presented at SAE Los Angeles Aeronautic Meeting, Oct. 8, 1954. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

## Based on discussion . . .


**Frederick Weiner**
North American Aviation, Inc.


Modular concepts must emphasize flexibility in order to be practical for a fighter-interceptor type airplane where only limited space is available and where other installation problems must

# Riss Buys 500 ROADRANGERS®

Riss & Company, Inc. of Kansas City, Mo., specified that every one of their new fleet of 500 tractors be *equipped with a Fuller Semi-Automatic R-950-C* ROADRANGER *Transmission.*

With *single*-lever control of all 10 forward speeds, the Fuller ROADRANGERS permit Riss drivers to *anticipate grade requirements* and meet them with the right ratio at the right time. The ten closely spaced ROADRANGER gear ratios can be readily anticipated and rapidly engaged, without having to wrestle with gear splits or wait for automatic actuation. And with all forward ratios in even 28% steps, they can match power precisely to load and grade demands and at the same time save fuel by keeping the engine operating in the maximum horsepower range.

• • •

For the most efficient, easiest-shifting transmissions available today . . . *specify Fuller Semi-Automatic* ROADRANGERS *for your fleet!*

**FULLER MANUFACTURING COMPANY**
**(Transmission Division) Kalamazoo, Mich.**

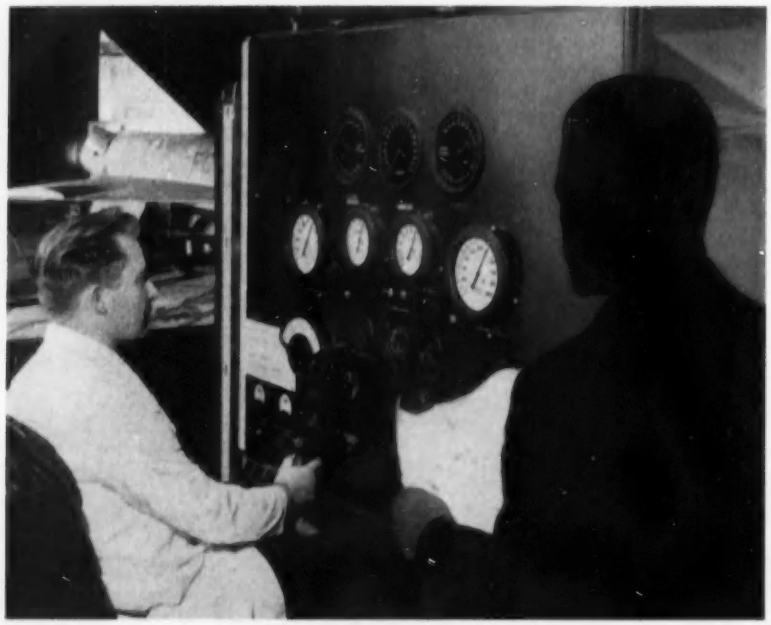
Unit Drop Forge Div., Milwaukee 1, Wis. • Shuler Axle Co., Louisville, Ky. (Subsidiary) • Sales & Service, All Products, West. Dist. Branch, Oakland 6, Cal. and Southwest Dist. Office, Tulsa 3, Okla.

TO THE FINE ENGINEERING MIND
SEEKING THE CHALLENGING PROJECTS IN

**HYDRAULICS AND CONTROLS**

**HYDRAULICS AND CONTROLS ENGINEERS** are urgently needed and offered exceptional opportunities now at Convair in San Diego, California. *Hydraulics Engineers* for analysis and selection of components, test stand operation and coordination, and training of field service personnel. *Hydraulic Servo Engineers* for system planning and analysis in relation to hydraulic operation of servo control systems. *Pneumatics Engineers* for design and selection of high pressure pneumatic actuators, weight reduction surveys on problems of hydraulics vs. pneumatics, and thermodynamic and fluid dynamic analysis of systems. *Controls Engineers* for layout and design of control system for high performance aircraft; coordination of powered flight controls with servo mechanism and hydraulic systems; automatic flight controls, including pilot assist, pitch and yaw damper; and other sub-systems analysis and design.

**CONVAIR** offers you an imaginative, explorative, energetic engineering department . . . truly the "engineer's" engineering department to challenge your mind, your skills, your abilities in solving the complex problems of vital, new, long-range programs. You will find salaries, facilities, engineering policies, educational opportunities and personal advantages excellent.



**SMOG-FREE SAN DIEGO,** lovely, sunny city on the coast of Southern California, offers you and your family a wonderful, new way of life . . . a way of life judged by most as the Nation's finest for climate, natural beauty and easy (indoor-outdoor) living. Housing is plentiful and reasonable.

Generous travel allowances to engineers who are accepted. Write at once enclosing full resume to:

**H. T. Brooks, Engineering Personnel, Dept. 704**

**CONVAIR**

*A Division of General Dynamics Corporation*

**3302 PACIFIC HIGHWAY** **SAN DIEGO, CALIFORNIA**

be combined with the electronic equipment installation.

It is to be deplored that the art of designing much present-day electronic equipment for good heat transfer by all of the three modes—conduction, convection, and radiation—has not been more highly utilized. As a result, large quantities of cooling air are required which impose, at times, an almost unacceptable penalty on the airframe manufacturer. The fault can be traced back to the lack of properly used mechanical principles in the basic design.

# In-Flight Loads Should be Measured

Based on paper by

**W. L. HOWLAND**
**and**
**C. J. BUZZETTI**
Lockheed Aircraft Corp.

EVERY Lockheed prototype airplane for the past twelve years has had a flight load measurement program conducted on it. The extent of the program is governed by several factors such as design assumptions used, data available in designing certain items, extent of stress analysis, weight penalties and safety. On different airplanes, different quantities are measured and to varying degrees.

The flight load program is carried out generally during the normal flight test, that is, it is sandwiched in with aerodynamic evaluation, engine tests, and stability and control tests. Seldom have flights been made for the specific purpose of measuring airloads. The amount of flight time spent on structural or airload measurements actually has been a small percentage of the total on any one airplane. But this situation is changing. In some instances, airplanes are now assigned exclusively to a structural load measurement program.

The heaviest costs incurred in flight load measurement are those for installation of instrumentation, calibration, and data reduction. One quantity which has been measured on a large number of airplanes is that of wing bending moment as a function of span. The use of IBM equipment for reducing the data has greatly increased the speed and accuracy with which final corrected results are available for determining future tests and/or modifications to be made.

Flight load measurements yield an intangible benefit in giving the test pilot or test crew confidence and a feeling of security when running critical or near limit load conditions. This can expedite certain programs an immeasurable amount. Valuable design

# Why the first gas turbine bus uses a Pesco fuel pump

Gas turbine transit bus, first of its kind, uses a 325-horsepower single burner turbine instead of the conventional diesel engine. Power plant engineers solved problem of fuel pump performance and service life with Pesco unit.

Are you developing or producing gas turbine engines for automotive, marine, aircraft or industrial applications? Then it will be of essential interest to know why the world's first gas turbine bus uses a Pesco High Pressure Fuel Pump.

On this radical new bus, the Pesco pump provides a continuous and dependable flow of fuel over an extended service life. It operates at sustained high volumetric efficiencies in spite of (1) the relatively high fuel system pressures encountered with gas turbine engines and (2) the inherent lack of lubricating value of the fuel.

The reason for such superior performance is the exclusive Pesco principle of pump design—"Pressure Loaded" bearings. This feature maintains continued new pump performance by automatically compensating for wear. It also assures constant pumping characteristics regardless of changes in temperature, viscosity or load.

Pesco, foremost producer of fuel pumps for aircraft jet engines, can supply fuel pumps for any type or size of gas turbine equipment. We will be pleased to work with you in developing a fuel pump to meet your specific requirements. Why not call in a Pesco sales engineer today. Contact: PESCO, 24700 North Miles Road, Bedford, Ohio.

Model 022816 High Pressure Fuel Pump, being used experimentally on gas turbine bus, is an engine-driven, gear-type unit. Compact in design and weighing only 3½ pounds, it is rated at 2.3 gpm at 3000 RPM at 650 psi.

engineering Pesco production

**PRODUCTS DIVISION**

**BORG-WARNER CORPORATION**

24700 NORTH MILES ROAD • BEDFORD, OHIO

information and high-speed, full-scale check on wind tunnel data, as well as stress analysis substantiation, can be secured. Flight measurements can tell definitely what loads become critical under maneuvering conditions as well as the magnitude of applied loads. Numerous structural failures in flight have been avoided by making measurements during progressive buildup tests.

On prototype airplanes, aside from any governmental or procuring agency requirements, flight load measurements of at least major structural items should be made to obtain the full utilization of the airplane's strength and capabilities. On several types of Lockheed airplanes the operating capabilities have been extended through such measurements. (Paper "Flight Load Measurements and Analysis" was presented at SAE Los Angeles Aeronautic Meeting, Oct. 7, 1954. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

### Excerpts from discussion:

**B. W. Hodges,** Boeing Airplane Co.

**Question:** How high were calibration loads carried and was it found necessary to recalibrate frequently?

**Answer:** Calibration was usually carried to about 20% of limit load depending somewhat on the indicated linearity which usually has been good. The sensitivity of equipment is high compared to that of flight instrumentation, thus relatively low calibration loads yield acceptable accuracy. Recalibrations were made every few flights and might be accomplished both before and after testing in the case of the most important tests.

**L. Hitchcock,** Boeing Airplane Co.

**Question:** How much calendar time was required to calibrate an airplane the size of the Constellation?

**Answer:** Calibration of the YC-130, including wing, fuselage and vertical tail, was accomplished in approximately one week.

**R. B. Davidson,** Northrop Aircraft, Inc.

**Question:** How were loads measured in unsymmetrical maneuvers such as rolling?

**Answer:** The best source of information on such unsymmetrical loads was plotted time histories of the maneuvers.

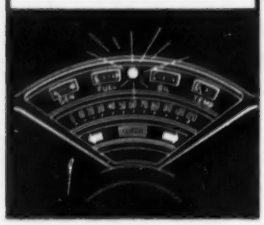
**Jerome Fishler,** Douglas Aircraft Co., Inc.

**Question:** Was the zero g bending moment found to change with altitude?

**Answer:** Yes, to some degree and apparently in accordance with change in Mach number.

**Question:** How many stations were considered when calibrating the YC-130?

**Answer:** There were four stations on one side of the fuselage, one on the other side and three on the vertical tail.



*Automatic "MEMORY" for motorists . . . . . .*

"FLASH! . . . DANGER! . . . OIL PRESSURE LOW!" That's the trouble-saving, money-saving warning this dependable new FASCO Low Pressure Indicating Switch never fails to deliver. It's small . . . but it's a BIG factor in keeping the motorist pleased with his car . . . another "plus" sales feature worth considering.

On "public carriers," the "451" FASCO also fills the need for a Low Pressure Indicating Switch for warning of low pressure in the air brake system.

*CONSULT FASCO . . . FIRST!*

AUTOMOTIVE DIVISION

FASCO

INDUSTRIES, INC.

ROCHESTER 2, NEW YORK

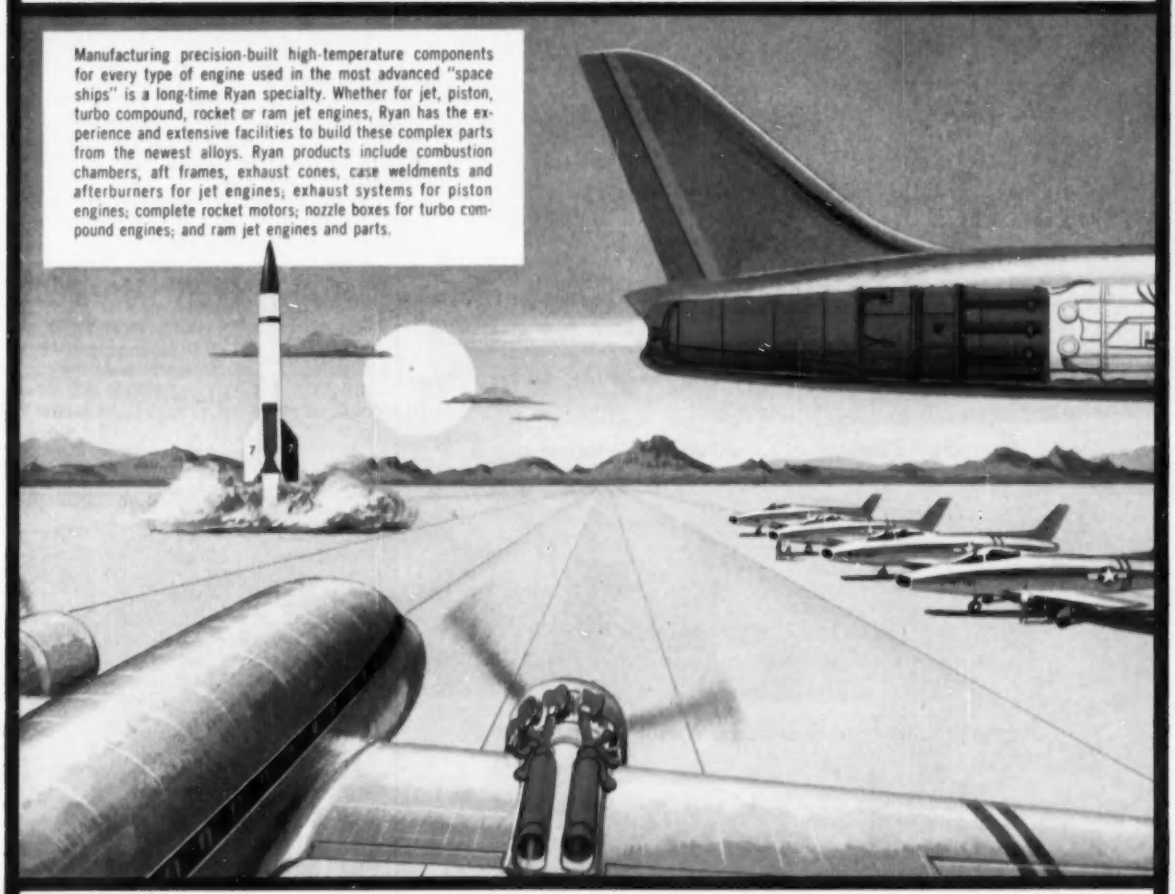
DETROIT OFFICE—12737 PURITAN—PHONE: UN 17476


## CRC Reports on Probe of End-Gas Properties

THE group on Fundamentals of Detonation in the Motor Fuels Division are searching for further information which will aid in a better understanding of what happens in the combustion chamber when detonation occurs. One approach being investigated is the instantaneous measurement of the temperature of the end gas or the last portion of the charge to burn.

Of the several possible methods

# HOT PARTS for "SPACE SHIPS"



Manufacturing precision-built high-temperature components for every type of engine used in the most advanced "space ships" is a long-time Ryan specialty. Whether for jet, piston, turbo compound, rocket or ram jet engines, Ryan has the experience and extensive facilities to build these complex parts from the newest alloys. Ryan products include combustion chambers, aft frames, exhaust cones, case weldments and afterburners for jet engines; exhaust systems for piston engines; complete rocket motors; nozzle boxes for turbo compound engines; and ram jet engines and parts.

## Another Example of How

# RYAN BUILDS BETTER

For complex aircraft engine components which must withstand searing temperatures, yet be built to jewel-like precision, leading engine makers have come to depend on Ryan—not only for production of current models, but also for development and initial manufacture of vital components of the most advanced design for power plants of the newest type.

Ryan's long and outstanding success as a designer and volume producer of aircraft and aeronautical products has been based on the ability to blend experience, skilled manpower and modern manufacturing methods into products supreme in quality, efficiently produced, delivered on time, and followed up by competent "after sale" service.

For 32 years Ryan has been in the forefront of aeronautical progress. It is uniquely equipped to solve the challenging research, engineering and production tasks associated with building, for America, the world's finest aircraft.

| | | | | |
|---|---|---|---|---|
| AIRCRAFT & COMPONENTS | AIRBORNE ELECTRONICS EQUIPMENT | RYAN AERONAUTICAL COMPANY SAN DIEGO 12, CALIFORNIA | AFTERBURNERS & JET COMPONENTS | PILOTLESS JET AIRCRAFT |
| METALLURGICAL ENGINEERING | WEAPONS SYSTEMS | | ROCKET MOTORS & RAM JETS | AIRCRAFT EXHAUST & DUCTING SYSTEMS |

# NO SINGLE ABRASIVE

## can do ALL blast cleaning jobs BEST

It is a fact that your own requirements as to finish and speed determine the type of abrasive you should use. As an example: for heavy cleaning chilled iron shot or grit is indicated; for less severe cleaning or scale removal annealed iron shot or grit may be used. Controlled T "chilled" and Permabrasive "annealed" shot and grit are engineered for the jobs they are to perform. We'll guarantee that our abrasives will produce a savings over your present abrasive costs or we will give you a check to cover the guaranteed savings.* How can you lose? Now is the time to make a test—now is the time to save on your blast cleaning costs.

*10% in the case of Permabrasive
15% in the case of Controlled T

*produced by*

THE NATIONAL METAL ABRASIVE COMPANY
*Cleveland, Ohio*

THE WESTERN METAL ABRASIVES COMPANY
*Chicago Heights, Illinois*

*SOLD EXCLUSIVELY BY*

**HICKMAN, WILLIAMS & COMPANY**
(INCORPORATED)

CHICAGO • DETROIT • CINCINNATI • ST. LOUIS • NEW YORK
CLEVELAND • PHILADELPHIA • PITTSBURGH • INDIANAPOLIS


of measuring end-gas temperatures namely, thermocouple, velocity of sound, absorption spectra and radiation, the most promising are the velocity of sound and absorption spectra techniques. This is the finding of the Group on Fundamentals of Detonation of the CRC, based on studies made at the Massachusetts Institute of Technology and the Universities of Columbia, Wisconsin and Michigan, published in a report entitled "Four Proposed Methods of Measuring End-Gas Properties."

Sponsorship for continuation of the velocity of sound and absorption spectra technique studies has been given by the Group. Support for these two techniques was decided because the ground work covered had been sufficient to indicate a reasonable chance of success, and within time and cost limitations. Running two projects concurrently was thought desirable because it provides possible cross checks on each method.

This progress report issued by the CRC includes the reports on the four techniques which the Group reviewed to arrive at its recommendation for further course of action.

This report (CRC-277) was prepared by the Group on Fundamentals of Detonation, Motor Fuels Division. It is 147 pages and 46 illustrations. It is available from SAE Special Publications Department. Price: $5.00 to SAE Members and $10.00 to nonmembers.

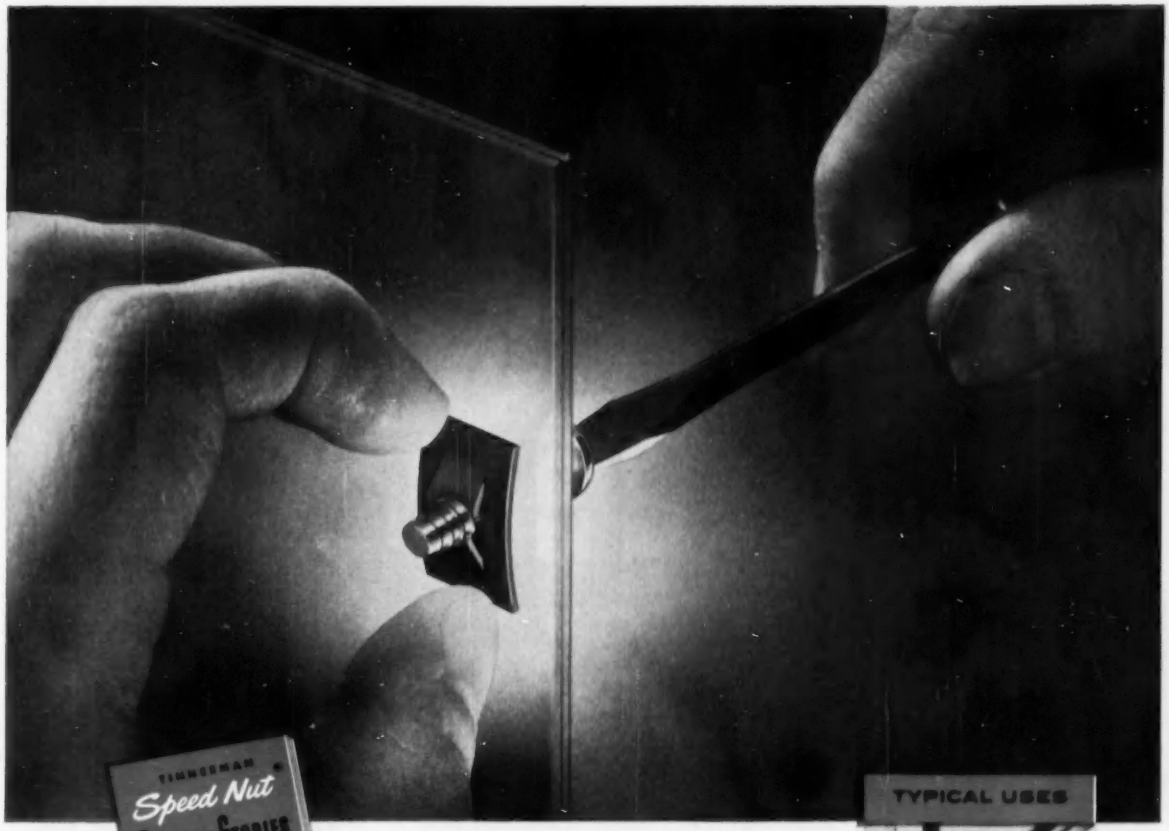
## PM Programs Vital For Modern Vehicles

Based on paper by


R. C. HUGO
Southwestern Bell Telephone Co.


SOME fleet operators, particularly those using the smaller vehicles, do not believe the cost of service and preventive maintenance is justified in view of the relatively short life expected from such units. But the trend of design toward higher horsepowers and compressions and closer tolerances of working parts, requiring the maintenance of critical adjustments, makes the need for proper servicing even greater.

If value is to be received from the invested vehicle dollar and if vehicles are expected to be reliable and safe to operate over a long and economical life, then a positive and adequate vehicle service and preventive maintenance program will go a long way toward achieving these objectives. (Paper "Vehicle Service Problems" was presented at SAE Kansas City Section, Oct. 12, 1954. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)




# Savings that come from tough little Arches of Steel

This is a familiar sight on assembly lines today . . . a Tinnerman SPEED NUT being pulled down tight on its screw, never to shake loose from vibration. Yet easy to loosen at the proper time without worry about rust-frozen screw threads.

The secret lies in the arched base and prongs of the SPEED NUT. As the screw is tightened, the flexible SPEED NUT flattens, setting in action two distinct forces that lock for keeps. Yet a firm twist of the screwdriver is all that is needed to relieve those forces and loosen the fastener.

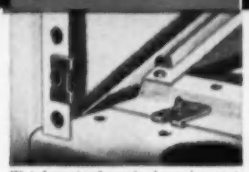
Savings in unit cost, in man-hours of application, in parts handling, are the important reasons why SPEED NUT brand fasteners are in service on your automobile, television set, home appliances and other assembled products. Write for "SPEED NUT Savings Stories", actual case histories of short cuts to assembly and production savings.

**TINNERMAN PRODUCTS, INC. • BOX 6688, DEPT. 12, CLEVELAND 1, OHIO**

*Canada*: Dominion Fasteners, Ltd., Hamilton, Ontario. *Great Britain*: Simmonds Aerocessories, Ltd., Treforest, Wales. *France*: Aerocessoires Simmonds, S. A., 7 rue Henri Barbusse, Levallois (Seine). *Germany*: Hans Sickinger GmbH "MECANO", Lemgo-i-Lippe.

TINNERMAN Speed Nuts®
FASTEST THING IN FASTENINGS®

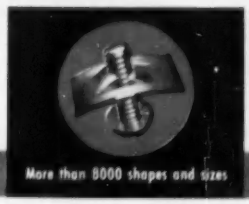
**TYPICAL USES**



Total cost of control-equipment enclosure reduced by 30% with "J" type SPEED NUTS!

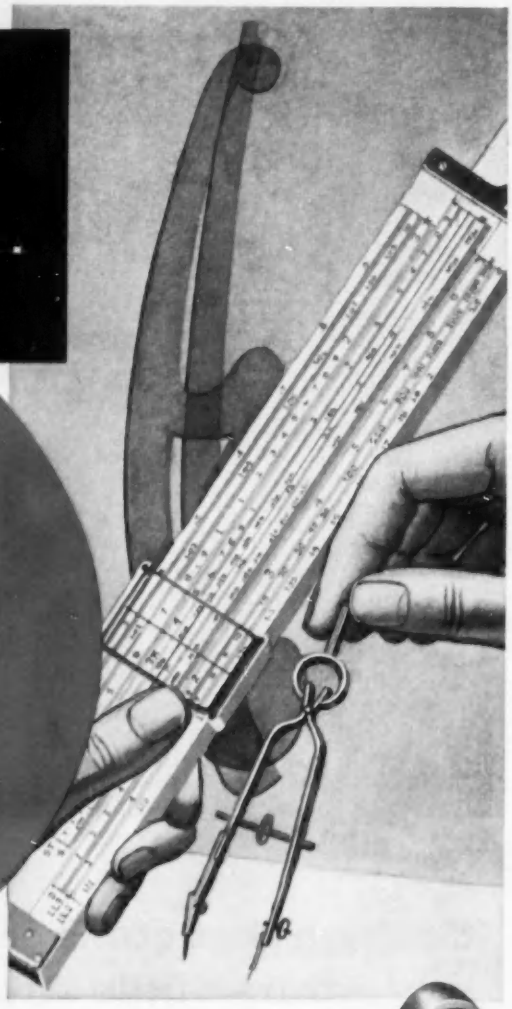
Specially developed SPEED NUTS cut assembly costs of adjustable awning by 63%!

SPEED NUTS lower assembly costs 40% on casement-window air conditioner!



# Engineer
## THE DESIGN WITH . . .

# DSP
## Leaf SPRINGS



FIFTY YEARS' experience in meeting the strictest specifications in the design and manufacture of leaf springs enables the Automotive Division of Detroit Steel Products Company to furnish springs which will perform exactly as required on the job for which they were designed.

That's why *the makers of most of America's trucks use DSP Leaf Springs as original equipment.*

SINCE 1904 — ORIGINAL EQUIPMENT ON CARS, TRUCKS, CABS, BUSES, TRAILERS

*Automotive Division*

**DETROIT STEEL PRODUCTS COMPANY**

*Also Makers of* Fenestra *Building Products*

**2250 E. Grand Blvd., Detroit 11, Michigan**

# New Test Evaluates Gasoline Gum Content

Based on paper by

C. C. MOORE
J. L. KELLER
W. L. KENT
and
F. S. LIGGETT

Union Oil Co. of California

TWO methods of evaluating gasoline for induction system gums have been developed as a result of dissatisfaction with existing tests which failed to show any deficiency in gasoline causing trouble in large-scale fleet tests.

The first method employed a Lauson engine. It separated gasolines definitely into good, fair, or bad categories; but its fuel, operating time, and manpower requirements were such as to make its usefulness limited despite significant results.

The Induction System Deposit Test (ISD) finally adopted is shown in Fig. 1. The apparatus consists essentially of a steam-jacketed glass U-tube, one arm of which is indented much like a Vigreux fractionating column. The gasoline sample is sprayed into the upper end of the indented arm where it flash evaporates in an ascending stream of warm air. Filtered atmospheric air is preheated in the other arm of the U-tube, flows up the indented arm countercurrent to the descending film of evaporating gasoline, and is withdrawn at the top by a line to the laboratory vacuum system.

The gasoline sample, 3000 ml, is contained in a reservoir equipped with an air inlet tube to maintain a constant head. It is protected from the light and flows by gravity from the reservoir through a flow meter, a regulating stop-cock, and to the fuel inlet nozzle. The air supply is passed through a cotton filter and an orifice flow meter before entering the preheater leg of the U-tube.

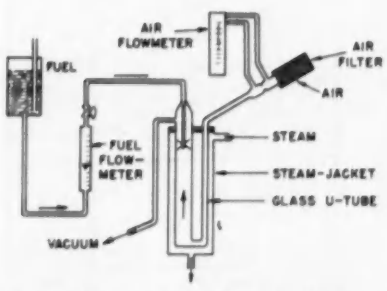



Fig. 1—This simple, easily maintained apparatus permits evaluation of induction system deposit gums in gasolines with greater accuracy than hitherto possible

The sample is evaporated, with close control of the flow rate, during exactly 2 hr. The air flow is adjusted so that the gasoline evaporates in the vertical section of the U-tube arm without permitting residue to collect in a puddle at the bottom and, so far as possible, so that liquid gasoline does not escape at the air-vapor outlet. The air-fuel ratio is variable, but typically averages 5.5:1 for premium grade gasolines. Following evaporation the gums are leached with hexane-heptane solvent, then dissolved in acetone. The acetone is evaporated to dryness and the gum residue weighed.

The ISD procedure requires 4 to 5 hr elapsed time and about 80 min of working time. The equipment is simple, requires no special maintenance and can be set up in any petroleum testing laboratory equipped with an adequate vacuum system.

Since the ISD test was designed to approach complete collection of gum from normal fuels, it cannot show any marked reduction in gum deposits from the use of detergent or solvent oil ad-

ROCKFORD
POWER
TAKE-OFFS
A SIZE AND TYPE
FOR EVERY USE
SELF CONTAINED UNIT
WIDE RANGE OF SIZES
CONSERVATIVE RATING
ROLLER BEARINGS
FINE ADJUSTMENT
ACCURATE BALANCE
S.A.E. DIMENSIONS
* ROCKFORD POWER TAKE-OFFS are available in standard sizes ranging from 125 foot pounds to 2100 foot pounds torque. Clutch sizes range from 6½ to 18 in. double plate. These complete, self-contained units are suitable for heavy-duty gear-tooth application to current industrial gasoline and diesel engines.
Send for This Handy Bulletin
Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.
BW
ROCKFORD CLUTCH DIVISION BORG-WARNER
▲ 316 Catherine Street, Rockford, Illinois, U.S.A. ▲
CLUTCHES

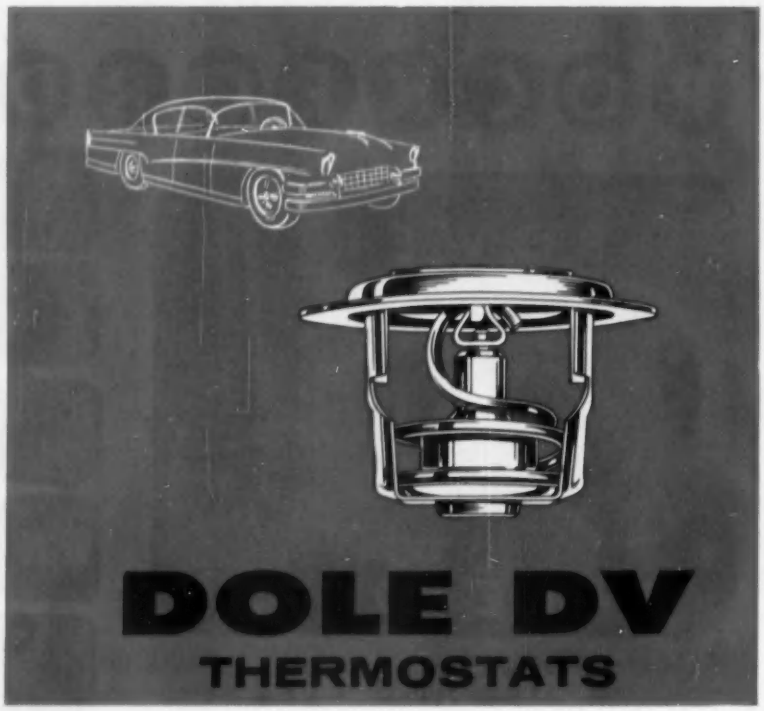
ditives. This is a marked advantage for many purposes and permits a closer measure of the total gum content. There is also a need for another test which will respond to the action of fuel additives so as to measure their true performance properly. (Paper "Evaluating Gasolines for Induction System Gums" was presented at SAE National Fuels and Lubricants Meeting, Tulsa, Nov. 4, 1954. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

## Based on discussion . . .

**E. P. Oke,** Anglo-Iranian Oil Co.

It is a weakness of both the laboratory test in glass apparatus described by the authors and of that used by ourselves that this technique may not show up the effect of additives designed to reduce manifold deposits, nor the effect of the heavy ends of fuel, since it avoids the flushing action which occurs on the manifold walls in an automobile engine.

In a service engine, and also in the Lauson engine test, the gum deposited must depend on two factors: (1) the intrinsic gum-forming property of the fuel, and (2) the ability of the fuel heavy ends or fuel additives to keep the gum in solution or suspension and prevent its deposition. Only when both of these factors are taken into account in a laboratory apparatus can a wholly satisfactory correlation with service behavior be expected.


*. . . for best engine performance*

Engineered for modern high-compression engine design to give accurate temperature control with pressurized cooling systems. Speeds warm-up—saves gasoline and oil—reduces engine wear. Gets more heat from the car heater.

Now original equipment on thirty-four (34) leading makes of cars, trucks, tractors, commercial vehicles, industrial and marine engines.

Literature sent on request—please use your letterhead.

*Control with Dole* TRADE MARK **DOLE**

THE DOLE VALVE COMPANY
1901 W. Carroll Ave., Chicago 12, Ill.
Detroit • Los Angeles • Philadelphia


# Economy and Safety Feature Jet Transport

Based on paper by


**M. L. PENNELL**
Boeing Airplane Co.


THE Boeing 707 jet transport can carry more payload, more miles per hour. Its work capacity in ton-knots is 3 to 4 times that of current transports. Thus the higher cost per hour is more than offset by the greater earning capacity.

Cost distribution (Fig. 1) shows fuel costs to be moderate by today's standards. Other costs are consistently

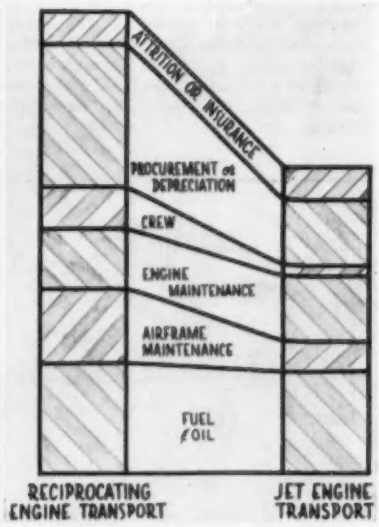
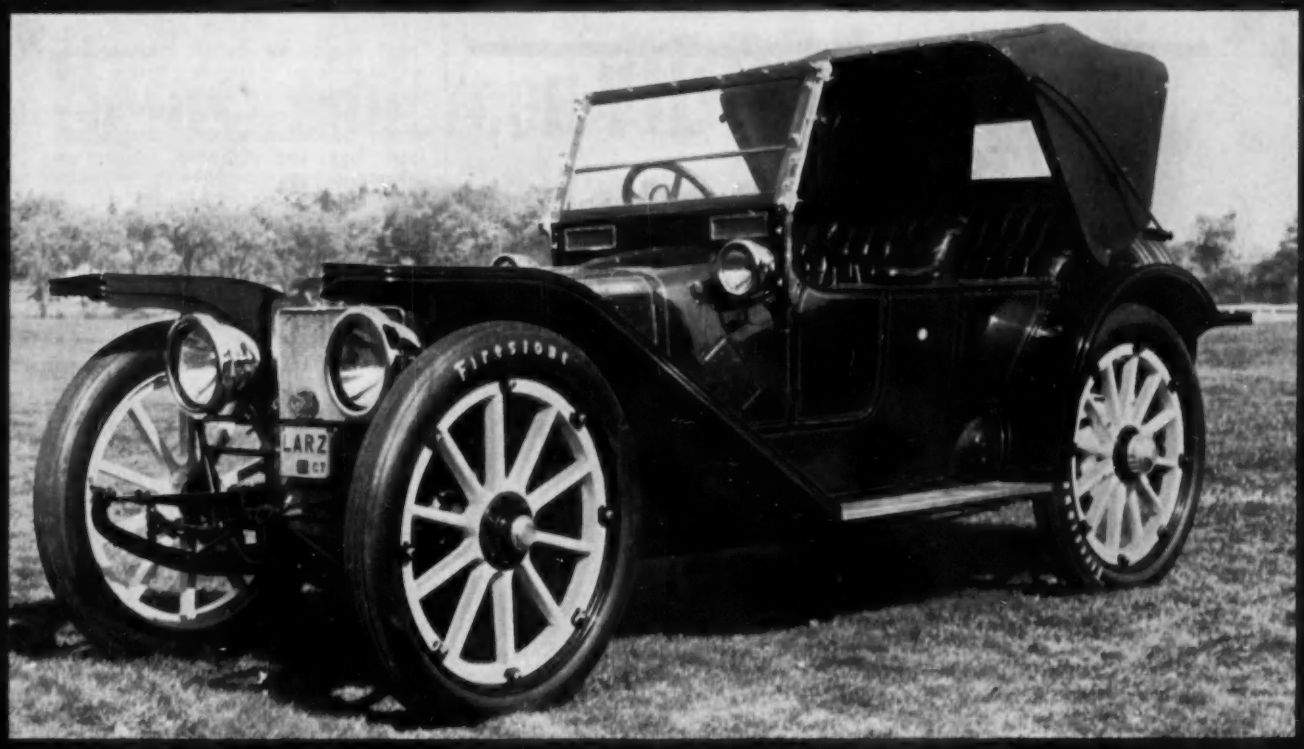



Fig. 1—Comparison of jet and reciprocating engine transport costs show the Boeing 707 jet leading in economy in all but engine maintenance which here includes spares and overhaul




*Send For Free Print—1910 American Underslung*

Directly opposite normal practice, the 1910 American Underslung featured a frame slung beneath the axles. With excellent road-holding capacities, it had a four-speed sliding-gear transmission, Bosch magneto ignition, and a 22-gallon fuel capacity.

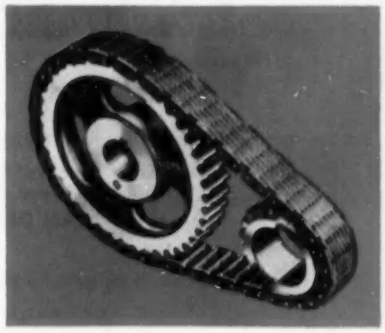
This is one of a series of antique automobile prints that will appear in future Morse advertisements. Write for your free copy, suitable for framing. Morse Chain Company, 7601 Central Avenue, Detroit 10, Michigan.

# 60,000,000 Timing Chains— and growing every year!

**Since the day** when the first "horseless carriage" raced along at the breakneck speed of 10 miles per hour, Morse has supplied the auto industry with over 60,000,000 Timing Chain Drives. In fact, of the seventeen automobile manufacturers who use Timing Chains as original equipment, *thirteen* specify Morse Timing Chain Drives.

Precision-built Morse Timing Chain Drives give longer service life and relative freedom from maintenance. They operate safely, quietly, and smoothly —with positive timing.

**Check into Morse** Timing Chain Drives, and other Power Transmission Products (see below) manufactured by Morse. We have expert engineers available to help you in your power transmission needs. Write today for quick assistance on your problem. MORSE CHAIN COMPANY, INDUSTRIAL SALES DEPT., ITHACA, NEW YORK.

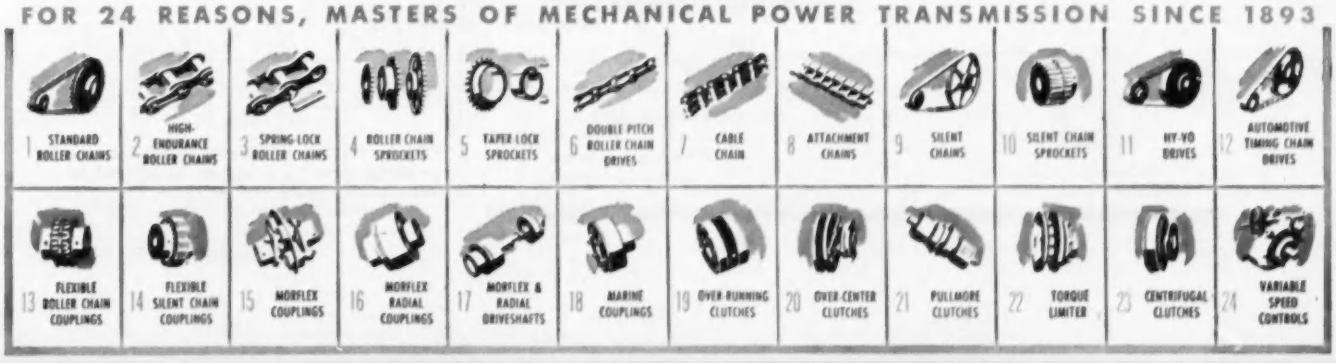


**MORSE**

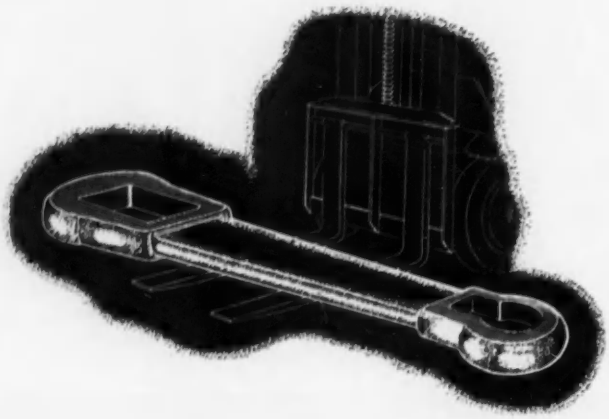
BW

**CHAINS, CLUTCHES, AND COUPLINGS**

FOR 24 REASONS, MASTERS OF MECHANICAL POWER TRANSMISSION SINCE 1893



# Worn? Mismachined?



## VANDERLOY* is the answer.

**Connecting rods, power cylinders, shafts, rods—i.d. or o.d. surfaces—all can be restored to design dimensions by the application of VANDERLOY.**

**VANDERLOY*** **an electrolytic iron that bonds atomically with most ferrous metals, aluminum, copper, nickel and their alloys.**

Write for additional information on this NEW reclamation service.
Dept. J-2, VAN DER HORST CORPORATION, Olean, N. Y.

VAN DER HORST

TERRELL, TEXAS
OLEAN, NEW YORK
LOS ANGELES, CALIFORNIA**
HILVERSUM, HOLLAND

*Patents applied for

**SparTan Engineering West Coast Licensee


lower except for engine maintenance which includes spares and overhaul on a very conservative basis.

Jets do not necessarily have to have longer fields for takeoff. Our prototype has demonstrated ability to takeoff in just over 2000 ft. What is true, however, is that a jet can be loaded up to the point where it requires a much longer field and still retain adequate performance characteristics once it is airborne.

Many earlier power plant problems are reduced in severity or eliminated. There are no propeller vibration problems, exhaust manifold problems, or critical cylinder cooling problems. This leads automatically to more reliability, hence to a better, safer plane. (Paper "Design Considerations of the Boeing Model 707" was presented at SAE Mid-Continent Section Meeting, Tulsa, Sept. 17, 1954. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

## Electronic Scales Weigh Trucks in Motion


Based on paper by

O. K. NORMANN

Highway Transport Research Branch, U. S. Bureau of Public Roads


Complete Paper will appear in 1955 SAE Transactions

WEIGHING trucks while rolling over the road is now a reality. Electronic scales under test by the Bureau of Public Roads have demonstrated an accuracy sufficient to indicate a possible outmoding of static weighing.

Weight recordings were made with trucks traveling at normal speeds which averaged 48 mph and varied from 30 to 60 mph. These weights

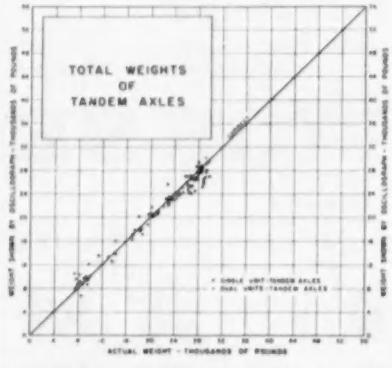
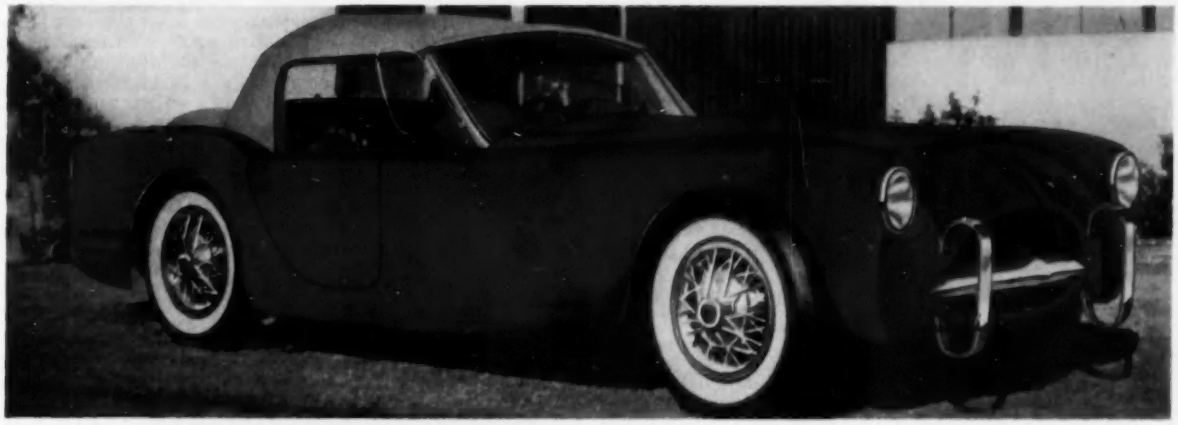



**Fig. 1—Accuracy obtainable with electronic weighing of trucks in motion is indicated by this plot of tandem axle weights. The comparison is made against static weights**

# Here's reinforced VIBRIN...in sport car bodies

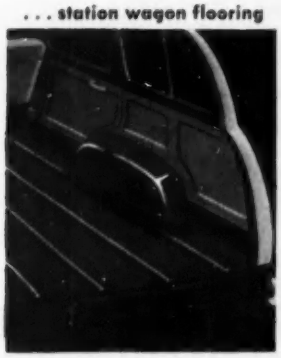
• DENT-PROOF • RUST-PROOF • ROT-PROOF
• STRONGER THAN STEEL BY WEIGHT • EASILY MOLDED TO COMPLEX CONTOURS
• SOUND DEADENING • RESISTANT TO OIL AND GAS • UNHARMED BY WEATHER



**WHY NOT reinforced Vibrin...?**

. . . seat frames

. . . station wagon flooring



. . . motorcycle sidecars

**Seat frames** of reinforced Vibrin could easily be molded in one assembly-saving piece... to body-cradling contours. They'd help eliminate spring squeak... or, with foam rubber, eliminate springs altogether. And they'd save weight, too.

**Station wagon flooring** of tough reinforced Vibrin could be molded in one large piece to eliminate dirt-catching cracks. It would never rust, never need painting... and would insulate against both heat and rattle. What's more, it would take all kinds of rough wear, could be ribbed to support practically any weight.

**Motorcycle sidecars** of this same material could be formed to any streamlined shape. The unusually light weight would facilitate removal of the sidecar assembly when desired. And they'd be natural heat insulators... and always pleasant to the touch.

**Why not?** Why not reinforced Vibrin *dashboards, roof frames for convertibles, splash pans, fender skirts?* Remember, industry is only *beginning* to take advantage of the unique properties this new material offers.

You'd better explore the *many* advantages reinforced Vibrin offers *you,* by writing for more information today.

## Naugatuck Chemical

Division of United States Rubber Company
Naugatuck, Connecticut

BRANCHES: Akron • Boston • Charlotte • Chicago • Los Angeles • Memphis • New York • Philadelphia • IN CANADA: Naugatuck Chemicals, Elmira, Ontario
Rubber Chemicals • Synthetic Rubber • Plastics • Agricultural Chemicals • Reclaimed Rubber • Latices • Cable Address: Rubexport, N.Y.

were then compared with static weights recorded for the same vehicles at lever-arm scales operated along the line of travel. Fig. 1 shows the result of accuracy tests for tandem axles.

Accurate weights of tandem axles in motion were originally the hardest to obtain. Apparently vibrations set up by the first axle were still present when the second crossed the scale. This was overcome by proper plates to check the horizontal movement of the platform so that now tandem axles are weighed with slightly greater accuracy than single axles.

Sixty percent of the vehicles now weighed while traveling at their normal speeds with an error under 5% and rarely is the error for a vehicle as great as 10%. The total tonnage traveling down a highway can be obtained with an error of only 2%. This is sufficiently accurate to obtain necessary information for highway planning purposes without inconveniencing the operators by making them stop and wait to be weighed. Any distribution of axle loads or total vehicle weights will be identical with similar weight distributions obtained by static weighing.

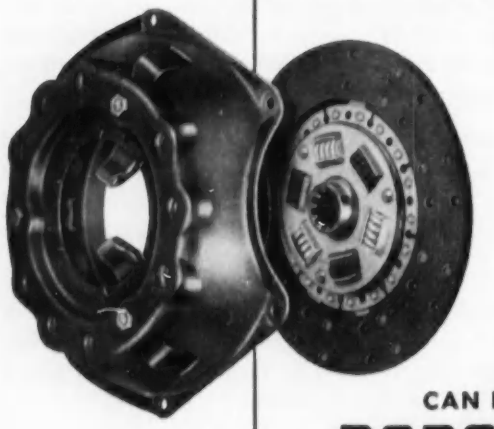
Other uses for electronic scales will develop, such as measuring impacts caused by surface roughness or uneven tire wear, and the efficiency of various types of truck suspension systems in reducing impact loads or variations between wheel loads, especially on tandem axles. Vehicle speeds and axle spacings can be recorded simultaneously.

Speeds can be measured to within 1 or 2 mph, and the average error in axle spacing when compared with taped measurements after stopping the vehicle is under 0.5 ft. This is sufficient for highway planning and permits the calculation of axle legal loads in states where axle weight limits vary with axle spacing. (Paper "Weighing Vehicles Static and in Motion by Electronic Scales" was presented at SAE National Transportation Meeting, Boston, Oct. 18, 1954. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)


Engineered by

BORG & BECK®

means . . . CLUTCHES built to the exacting standards which have made the name BORG & BECK famous for 36 years!



YOU CAN DEPEND ON

BORG & BECK®

CLUTCHES . . . FOR THAT VITAL SPOT WHERE POWER TAKES HOLD OF THE LOAD

Reg. U.S. Pat. Off.

BORG & BECK CLUTCH THE STANDARD

BW

BORG & BECK DIVISION
Borg-Warner Corporation
CHICAGO 38, ILLINOIS


## Advance in Lubricants Launches New Cycle

Based on paper by


C. M. LARSON
Sinclair Refining Co.


TWENTY-FIVE years ago there were only light, medium and heavy motor oils, cup grease for the chassis, and the trade-branded 600W for transmission and rear axle lubrication. Today, after developing a wide variety of lubricants to satisfy the full range of climatic needs and service requirements, we are back to one motor oil, one gear lubricant, a grease, and one automatic transmission fluid—four multigraded, multi-purpose products capable of lubricating excellently the vast majority of vehicles on the road.

The multigraded motor oils of the double SAE 10W-20 and the triple viscosity SAE 10W-30 grades are now recommended for use from temperatures of -10 F to over 90 F. They meet the two basic requirements: that viscosity shall be suited to working temperatures, and that it shall not be excessive at starting temperatures.

At the same time, multigraded, multi-purpose gear oils and greases are gaining favor because they are more flexible in meeting climatic and service requirements than single-graded products. (Paper, "Fifty Years of the SAE and Today's Technical Developments of Automotive Lubricants" was presented at SAE Atlanta Group, Jan. 3, 1955. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

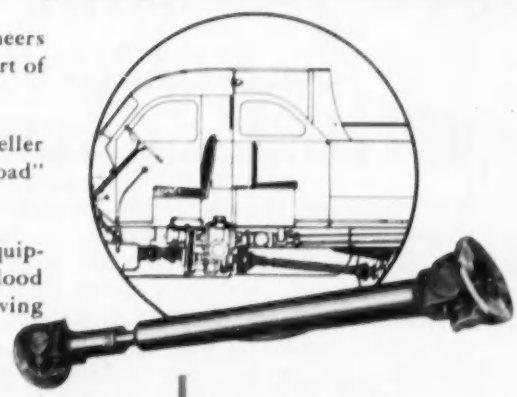
# FIRE WON'T WAIT

## so Seagrave insures dependable power transmission with BLOOD BROTHERS propeller shafts

With fire apparatus, *every* trip's an emergency! So Seagrave engineers provide *extra* stamina and *extra* emergency reserve in every part of these famous fire-fighting units.

Motors, bodies, pumps . . . and rugged Blood Brothers Propeller Shafts are *all* ready at a moment's notice for gruelling "peak load" service in thousands of cities.

Your problems may be different — involving other specialized equipment or work-a-day truck and bus production. Yet you'll find Blood Brothers' engineers highly competent and cooperative in solving universal joint and propeller shaft problems. Why not arrange a conference — at your convenience?



**BLOOD BROTHERS**
**MACHINE DIVISION**
*ROCKWELL SPRING AND AXLE COMPANY*
**ALLEGAN, MICHIGAN**

**UNIVERSAL JOINTS AND DRIVE LINE ASSEMBLIES**

## SAE Golden Anniversary Passenger Car, Body, and Materials Meeting

Continued from page 72

### Plymouth V-8 Engine

The new Plymouth engine is a 90 deg V-8 having a bore and stroke of 3.563 × 3.25 in., piston displacement of 259.2 cu in. Compression ratio is 7.6:1. It is rated at 167 hp and 231 lb-ft torque. A modified hemispherical combustion chamber combines high efficiency and simplicity. . .

. . . **H. L. Welch, Chrysler Corp.**, "The New Plymouth V-8 Engine."

### Body Engineering

All design criteria for body structure fit rather nicely into (1) stiffness, (2) strength, (3) durability. The side framing is the essential structure providing body stiffness under both beaming and torsional loading. To be effective it must be tied to the chassis frame. Less height and more glass in modern cars means less available space to provide upper structure. . .

. . . **P. O. Johnson, General Motors, Corp.**, "Automobile Body Loads."

"Body-in-white" assembly, less doors and deck lid, contains approximately 225 individual sheet metal stampings. Assembly is difficult because they vary with each production run.

Spot welding should be the principle method for joining components because it permits the use of automatic equipment, or portable welders where automatics can't be used, and produces less heat, thereby minimizing distortions.

. . . **J. W. Richards, Ford Motor Co.**, "Automobile Body Structures."

A body that is well designed will weigh less than one which is poorly designed. Cost and weight go together, therefore we must be weight conscious. Parts should perform as many functions as possible. . .

. . . **W. J. Clark, Chrysler Corp.**, "Body Efficiency."

### Cam-Tappet Distress

Engine and road tests show that cam-tappet distress occurs most often between 5000 and 10,000 miles of operation and may take several forms: scuff, fatigue, smooth wear, and oil fatigue. Cam lobe surface finish influences the cam scuffing tendency very much; increasing lubrication has no appreciable effect. . .

. . . **M. F. Garwood, D. R. Kinker, and J. J. Manganello, Chrysler Corp.**, "Considerations Affecting the Life of Automotive Camshafts and Tappets."

Tappet material and camshaft material have intangible qualities as individual parts. The compatibility between the two parts is what counts. Important findings in tappet testing are most likely to occur when the tests involve a large number of parts, since only large numbers will permit the study of trends on a frequency basis.

. . . **J. S. Laird, C. L. Stevens, and V. L. Iles**, Ford Motor Co.

Every effort should be made to design cams and tappets for minimum contact stresses, minimum deflection of mating parts, and minimum rubbing velocities. Surface finish and treatment are important. Different materials have different degrees of compatibility with various designs and lubricants. . .

. . . **E. B. Etchells, R. F. Thomson, G. H. Robinson, G. K. Malone**, Research Lab. Div., General Motors Corp.

Colorful automotive styling will increase the use of butyl rubber. It is possible to apply color coatings to weather resistant butyl parts and get much better adhesion than with the same type of coatings applied to GR-S or natural rubber compounds. . .

. . . **W. J. Simpson, Chrysler Corp.**, "New and Improved Elastomeric Materials for Automotive Use."

### Packard V-8 Engine

Free breathing results from painstakingly designed passages. Overhead valves, 25% larger in head area than those used in the 1954 engine, provide maximum volumetric effi-

THE WORLD'S LARGEST PRODUCER OF READY - TO - INSTALL POWER PACKAGES FOR AIRPLANES INVITES YOU TO ENJOY YOUR WORK *AND* YOUR LIFE IN

*beautiful*

SOUTHERN CALIFORNIA

We believe we can offer you an opportunity to improve your position in the business world – and improve your way of life here at Rohr Aircraft Corporation in beautiful, temperate, exciting Southern California. To strengthen our personnel in various departments, Rohr has a real opportunity for you if you are skilled as an –

**ENGINEER (Aircraft Design or Structures) LOFTSMAN**
**JIG & FIXTURE BUILDER TOOL PLANNER TOOL DESIGNER**

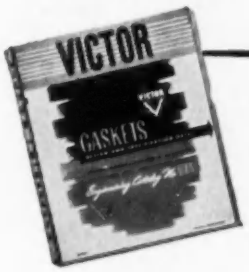
ROHR
AIRCRAFT CORPORATION

Please write giving complete details and we will answer immediately.

*Mr. Ned DeWitt, Personnel Department 44*
**Rohr Aircraft Corporation**
Chula Vista, California

9 miles south of San Diego on sunny San Diego Bay.

**YOUR COMPLETE GUIDE TO GASKET MATERIALS—** Victor Engineering Catalog No. 505. If you don't have a copy, please request one on your letterhead.




Where non-metallic or "soft" gasket materials are to be specified, design engineers will find only VICTOR with the complete line of packings for each specific need.

For automotive or aeronautical purposes, you choose from dozens of highly developed fibrous and synthetic rubber compositions—each distinctly classified by SAE-ASTM specifications . . . each a superior sealing element in recommended applications.

Technical counsel is available without obligation. Whether you specify packings in sheets or finished gaskets, your product can have the advantage of Victor's leadership in sealing engineering—without added cost.

There's a Victor Field Engineer in your area—or contact the home office. Victor Mfg. & Gasket Co., P.O. Box 1333, Chicago 90, Ill.

THE MARK OF QUALITY
VICTOR
LEADERSHIP THRU PIONEERING

# VICTOR

"ORIGINAL EQUIPMENT"
**GASKETS • OIL SEALS • PACKINGS**

*SEALING PRODUCTS EXCLUSIVELY*

ciency. Short stroke increases mechanical and thermal efficiency. . .
. . . **W. E. Schwieder**, Packard Div., Studebaker-Packard Corp.

## Rubber For Automobiles

In 1930 the average automobile used rubber for 175 items weighing 33 lb; in 1940 for 267 items weighing 57 lb; in 1950 for 540 items weighing 100 lb. This large increase required a standardization of methods of specifying different types and properties of rubber. There is still much work to be done to develop new synthetic rubber materials to function under severe conditions. . .
. . . **J. J. Allen, Firestone Tire and Rubber Co.**, "Natural and Synthetic Rubber in the Automotive Industry."

There is no one ideal material for fluid seals. The various materials have certain outstanding characteristics which make them favorable for certain uses and undesirable for other uses. Materials having the best low temperature flexibility do not always have the best oil resistance. . .
. . . **R. H. Barbour, Chicago Rawhide Mfg. Co.**, "Fluid Seals."

Chromium plated trim around a windshield or backlight gasket retards cracking of rubber weather seals. Seasonal conditions, and geographical location also play dominant roles. . .
. . . **H. A. Winkelmann, Sheller Manufacturing Co.**, "Weather-seals in Automotive Applications."

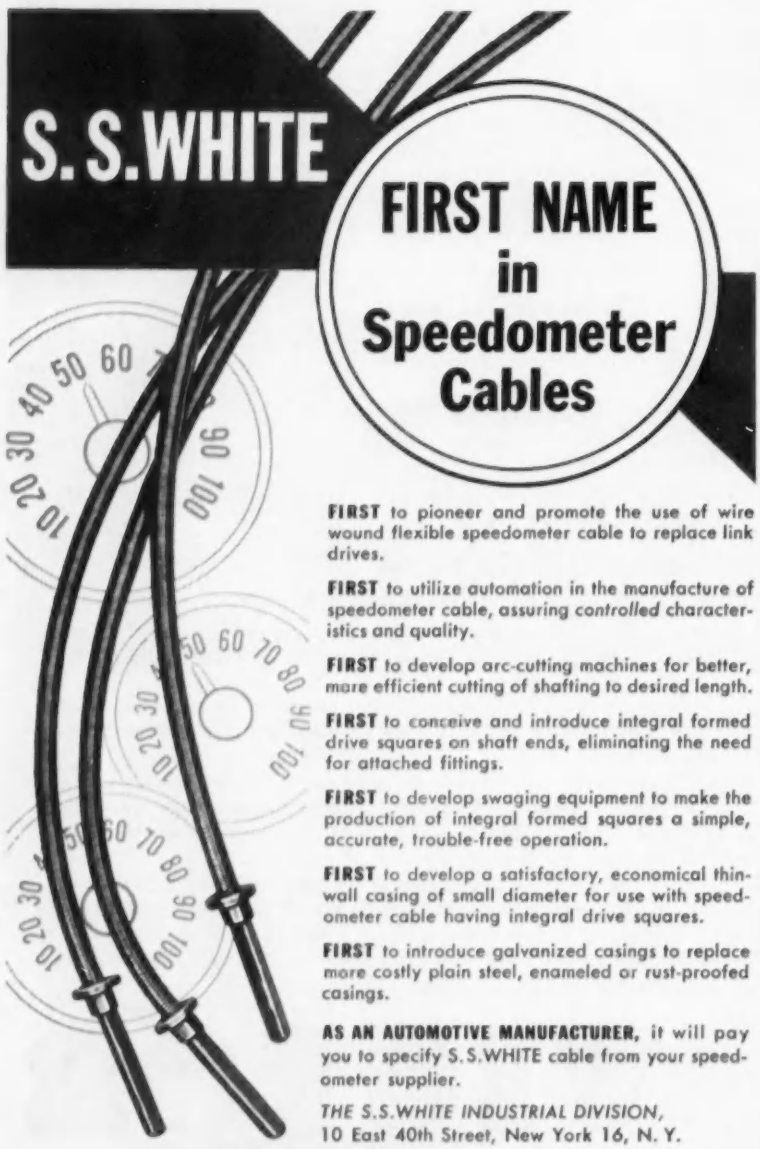
In engine mount work, dynamic rate and hysteresis are the two factors that control vibration and contribute most greatly to the all important "car feel" that rates a position of importance these days next only to upholstery, horsepower, and sex appeal. . .
. . . **R. P. Schmuckal, Ford Motor Co.**, "Rubber Has Dynamic Properties, Too."

## Future Car Styling

In the late 1930's Edsel Ford had a special car built for him with a new design theme—low, square, and large windows. His friends admired it so much that a limited number were built for them. Demand got greater and greater. This was the Lincoln Continental. . .
. . . **D. C. Woods, Ford Motor Co.**, "Styling A Dream Car."

We can't expect the public to design our cars for us. It is up to the stylists, the engineers, and various other technical people to use their skills and specialized training to look ahead of the crowd and offer advancements which are beyond the conception of the layman. . .
. . . **Marsden Thompson, General Motors Corp.**, "Evaluating Automobile Styling."

Preliminary drawings are used by tool and chassis engineers in determining the most economical major stamping arrangements and efficient chassis layouts. Vital tooling and methods of assembly are studied. Precise, microscopic cost control must be exercised all along the way. . .
. . . **J. W. Shank, Chrysler Corp.**, "Body Engineering—Bringing Dream Cars To Reality."



S.S.WHITE
FIRST NAME
in
Speedometer
Cables
FIRST to pioneer and promote the use of wire wound flexible speedometer cable to replace link drives.
FIRST to utilize automation in the manufacture of speedometer cable, assuring controlled characteristics and quality.
FIRST to develop arc-cutting machines for better, more efficient cutting of shafting to desired length.
FIRST to conceive and introduce integral formed drive squares on shaft ends, eliminating the need for attached fittings.
FIRST to develop swaging equipment to make the production of integral formed squares a simple, accurate, trouble-free operation.
FIRST to develop a satisfactory, economical thin-wall casing of small diameter for use with speedometer cable having integral drive squares.
FIRST to introduce galvanized casings to replace more costly plain steel, enameled or rust-proofed casings.
AS AN AUTOMOTIVE MANUFACTURER, it will pay you to specify S.S.WHITE cable from your speedometer supplier.
THE S.S.WHITE INDUSTRIAL DIVISION,
10 East 40th Street, New York 16, N. Y.
8-A
FIRST NAME
S.S.White
in flexible shafts for speedometer drives, industrial power drives and remote control.

# Challenge to designers

**Stimulating new booklet** shows how Mullins *Koldflo** process extrudes precision steel parts! Send now for this new 20-page booklet about cold steel extrusion by Mullins *Koldflo*. It shows you how to design intricate cylindrical steel parts for one-piece production. Parts with a glass-smooth bore, extremely close tolerances. Parts that are better designed and cost less to produce. For your free copy fill out and send the coupon now. Or call our nearest district sales engineering office: New York, 500 Fifth Avenue, Phone—Pennsylvania 6-2773; Detroit, 18268 James Couzens Highway, Phone—Diamond 1-1490; Chicago, 332 South Michigan Ave., Phone—Harrison 7-3725.

*Trade Mark

**Typical hydraulic cylinder produced by Mullins Koldflo* process. Length 15 inches, I.D. 2¼ inches.**

**Koldflo**
**DIVISION**
MULLINS MANUFACTURING CORPORATION
Warren, Ohio

**Phone—2-1166**

**MULLINS MANUFACTURING CORPORATION, Dept. K-4**
**Koldflo Division • Warren, Ohio**

Please send free copy of "How would you tool-up to make an egg?" (Second edition)

*Name* _____

*Title* _____

*Company* _____

*Address* _____

*City* _____ *State* _____

LISLE Magnetic PLUGS

Reduce Wear

Write for FREE Sample Plug for Testing
State size and type of Lisle Plug desired.

LISLE Corporation
Clarinda, Iowa

## About SAE Members

continued from page 82

**JULIUS A. RIEDL** has taken a position with American Motors Corp. Milwaukee Body Plant as works manager. He had been master mechanic in Detroit for American Motors Corp. on the engineering staff of the vice-president of manufacturing.

**TRANT R. JARMAN** has taken a position with Chrysler Corp. in Detroit as experimental road test engineer. Formerly he had served as development engineer with Aircooled Motors, Inc., in Syracuse, N. Y.

**JOSEPH GESCHELIN**, Detroit editor, Chilton Publications, will address a meeting of The National Foremen's Association in Philadelphia on April 19. Subject of his talk will be "Automation—What it is; and Where it fits."

**CLYDE H. SCHAMEL** has been appointed assistant senior-engineer-in-charge of the Engineering Section's Experimental and Development Department of Fisher Body Division, General Motors Corp. He had been engineer-in-charge of Mechanical Design and Ordnance Development.

**RICHARD C. JONES** has been appointed sales manager for Inland Truck & Diesel Co. in Spokane, Wash. He had been serving as fleet sales manager for Gilbraith Motor Co. in Tacoma, Wash.

**NORMAND VARY** (Parks College '54) has joined Sikorsky Aircraft Division of United Aircraft Corp. as service representative.

**RUDY NEISSER** (Northrop Aeronautical Institute) is now sales supervisor for Neisser & Co., of Lima, Peru.

**RAYMOND E. WIEVIG** (Northrop Aeronautical Institute '54) is now associated with Ryan Aeronautical Co., San Diego, as junior engineer.

**S. K. CANNON** is now associated with the Ford Motor Co., Edgewater, New Jersey plant as general production manager. He had been production manager of the Ford Kansas City Aircraft plant. As general production manager, Cannon is responsible for all phases of production connected with the assembly of passenger cars and trucks.

**LAWRENCE J. GILSDORF**, previously assistant staff electrical engineer for Willys Motors, Inc., has taken a position with Chrysler Corp. in Detroit as a design and development engineer.

**WILLIAM J. CURRER**, previously serving in Rhodesia as director of Triplejay Equipment Proprietary, Ltd., is now serving in that position in Johannesburg, South Africa.

# "WORLD'S LARGEST TRUCK"

## USES VICKERS® HYDRAULICS for STEERING and DUMPING

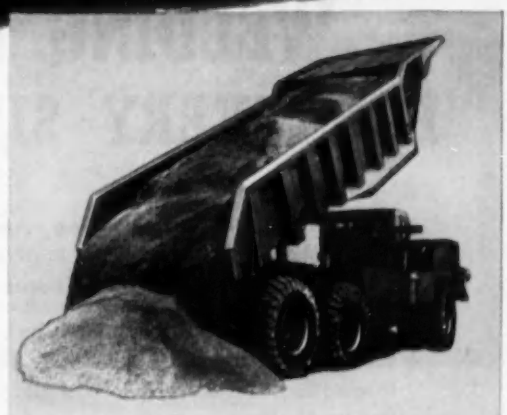
*Dart Model 60 Truck is shown carrying full 75-ton payload.*

This Dart behemoth with a gross vehicle weight of 240,000 lb is said to be the largest truck in the world. It has two engines totaling 700 horsepower. Everything about it is on a colossal scale.

A new hydraulic circuit was developed by Vickers expressly for Model 60. The driver steers this truck with no more effort than he would a passenger car as the steering gear merely actuates the valve that controls the flow of oil to the steering cylinders. Twin cylinders provide 50,000 lb steering force (at 1000 psi oil pressure) for the dual front wheels.

Dart is thoroughly familiar with the many advantages of Vickers Hydraulic Power Steering having used it since 1938.

Vickers hydraulic equipment is available for all types and sizes of mobile equipment. Ask for new Catalog M-5101.



*Vickers hydraulic power dumps the load; twin hoists are rated at 130,000 lb push at 1000 psi oil pressure.*

## VICKERS Incorporated

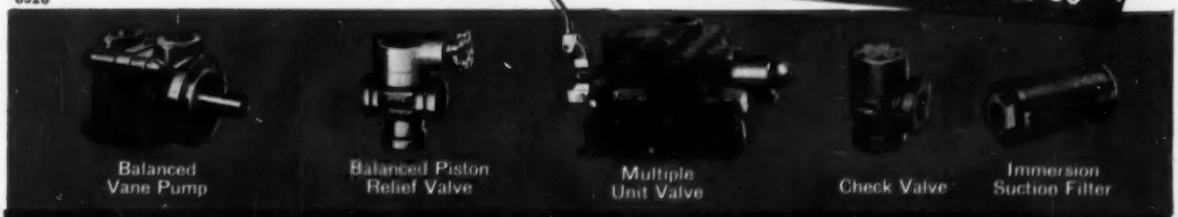
*DIVISION OF THE SPERRY CORPORATION*

**1440 OAKMAN BLVD. • DETROIT 32, MICH.**

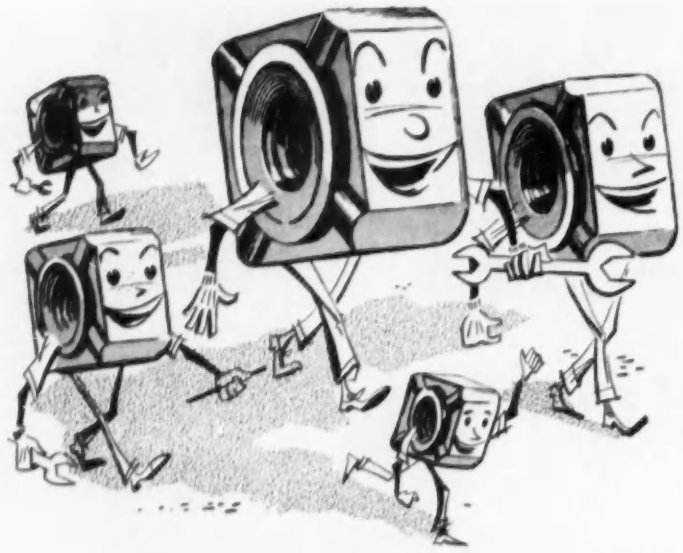
Application Engineering Offices: ATLANTA • CHICAGO AREA (Brookfield) CINCINNATI • CLEVELAND • DETROIT • HOUSTON • LOS ANGELES AREA (El Segundo) • MINNEAPOLIS • NEW YORK AREA (Summit, N. J.) PHILADELPHIA AREA (Media) • PITTSBURGH AREA (Mt. Lebanon) ROCHESTER • ROCKFORD • SAN FRANCISCO AREA (Berkeley) SEATTLE • ST. LOUIS • TULSA • WASHINGTON • WORCESTER

6526

**REPRESENTATIVE STANDARD VICKERS UNITS USED ON DART MODEL 60**




**ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921**



THERE'S A

MIDLAND

WELDING NUT

FOR EVERY SIZE JOB!

***For Fabricating, Fastening, and Assembling Metal Parts . . . Midland Welding Nuts are the Answer!***

No matter what your product—whether big or small—if there's metal fabricating, fastening, or assembling involved, chances are you can use Midland Welding Nuts to big advantage.

Now relied on by manufacturers the world over—and specified universally by product designers—Midland Welding Nuts will lower your assembly costs and speed up operations all along the line for you.

***Write or phone for complete information.***

**THE MIDLAND STEEL PRODUCTS CO.**

6660 Mt. Elliott Avenue • Detroit 11, Michigan

*Export Department:* 38 Pearl St., New York, N.Y.

*Manufacturers of*

**AUTOMOBILE AND TRUCK FRAMES** | **AIR AND VACUUM POWER BRAKES** | **AIR AND ELECTRO-PNEUMATIC DOOR CONTROLS**

## New Members Qualified

These applicants qualified for admission to the Society between February 10, 1955 and March 10, 1955. Grades of membership are: (M) Member; (A) Associate; (J) Junior.

**Alberta Group**

Gerald C. Wates (A).

**Atlanta Section**

Lewis S. Alexander (A), E. Charles Clifton (A), Luther Don Loughridge, Jr. (A).

**Baltimore Section**

Wilbur C. Kern (M), Leonard G. Rado (J), Frederick Charles Ziemer, Jr. (A).

**Canadian Section**

Earl D. Brunt (A), Frederick Allan Knight (A), Sidney G. Letts (M), Keith Pettigrew (J), Frank Sommers (A), B. John White (A).

**Central Illinois Section**

Richard Henry Axness (J), Wallace S. Baker (J), James William Crane (J), Raymond M. Erkkila (J), John G. Frantzreb (M), John A. Immel (M), Jackson C. Medley (J).

**Chicago Section**

Henry Berolzheimer (J), Gordon Leith Hershman (M), Thomas P. Hurst (M), Malio A. Leone (J), John Liu (J), Douglas George Lytle (A), Pierce Richardson (M), Robert W. Washington (M).

**Cincinnati Section**

Harry B. Dorman (A), Leonard E. Good (M), Louis J. Thieken (A).

**Cleveland Section**

Torris W. Crooks (A), James P. Galm (J), George H. Gates (M), Gregory B. Gilmore (J), Alvin R. Morris (A), Leo E. Novak (J), Ralph H. Riedel (J), William Speicher (M).

**Colorado Group**

Norman A. Olson (A).

**Dayton Section**

Kenneth C. Lockhart (J).

**Detroit Section**

Lawrence T. Adams (J), Robert F. Anderson (M), Clinton P. Atwood (J), John H. Baer (M), Nick Baracos (J), Armand J. Bilitzke (M), Louis M. Blanchette (J), Donavon Downham (J), Robert Irving Fannin (J), Fred E. Freiheit (J), Robert E. Gibson (J), Richard M. Greff (M), Theodore Edward Kashmerick (M), Frank A. Knopf, Jr. (J), Joseph Malusovich (J), Michael Master (A), Patrick R. Moore (M), Franklin Vance Naugle (J), Peter P. Parsons (J), George J. Payne (J),

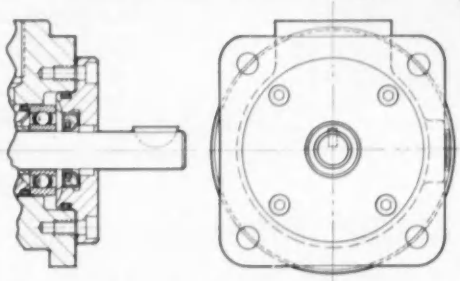
# One Waldes Truarc Ring Saves a Pound in Weight Replaces Cast Retainer Plate and Four Screws

### Denison Vane Type Pump/Motor

The Denison Engineering Company of Columbus, Ohio uses a Waldes Truarc Beveled Retaining Ring (Series 5002) in their pump/motor to achieve a simpler, lighter, more easily assembled unit and to cut both material costs and production time.

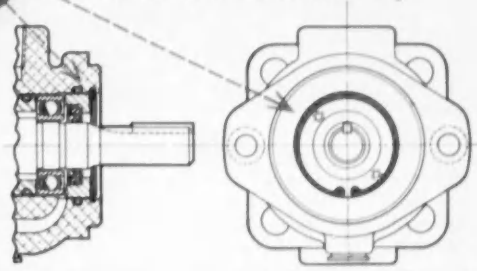
This vane-type power package operates as either a fluid pump or motor without alterations of any kind. Built for 2000 psi continuous duty, rugged construction was essential.

### Shaft Seal Subassembly



**Experimental Way:** One cast retainer plate plus four socket head cap screws hold unit together. Assembly requires skilled labor, machinery, time-consuming careful adjustment.

### Shaft Seal Subassembly



**Truarc Way:** Waldes Truarc beveled retaining ring (internal 5002) retains shaft and bearings, takes up accumulated tolerances rigidly, prevents leakage around shaft. Unit is one pound lighter. Assembly is quick and easy, more economical.

Wherever you now use machined shoulders, bolts, snap rings, or cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better, more economical job. Truarc Rings are precision engineered, quick and easy to assemble and disassemble.

More than 5,000 stock-sizes of the different Truarc ring types available. Ninety stocking points throughout U. S. A. and Canada.

Find out what Waldes Truarc Retaining Rings can do for you toward reducing costs and improving your product. Send your blueprints to Waldes Truarc Engineers for individual attention without obligation.

For precision internal grooving and undercutting . . . Waldes Truarc Grooving Tool!

Send for new catalog supplement

**WALDES**

**TRUARC®**

**RETAINING RINGS**

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

**Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.**

**Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.**

***(Please print)***

*Name*.....

*Title*.....

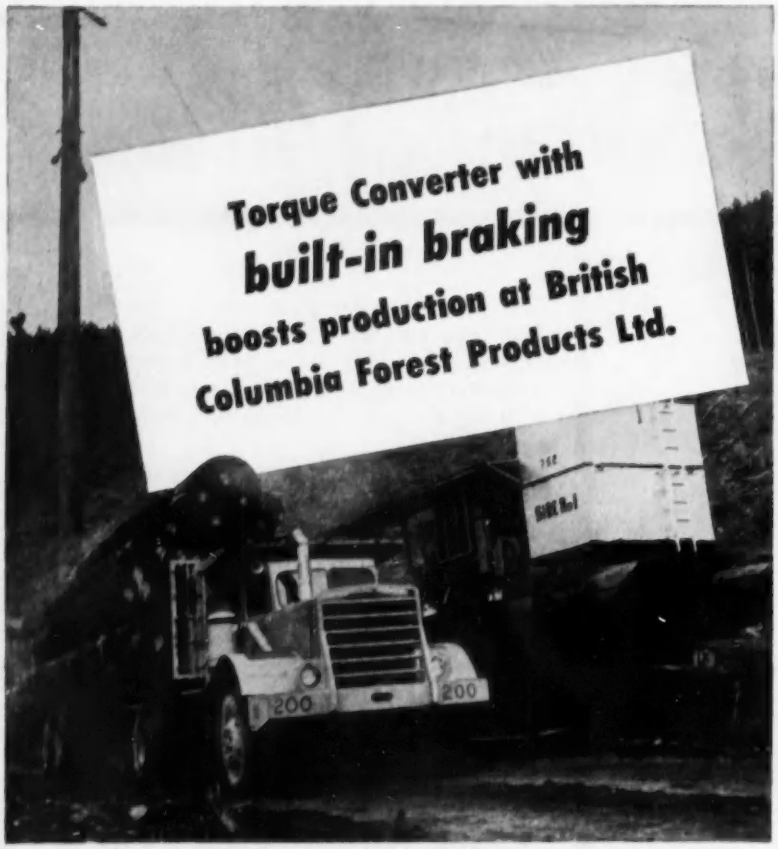
*Company*.....

*Business Address*.....

*City*.....*Zone*.....*State*.....

SA-047

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.




At B. C. Forest Products Ltd., Model CD-849 Kenworth (shown) and Model HDX-30-80 Hayes logging trucks work through Twin Disc Model DF Truck-Type Torque Converters. Write to Hydraulic Division, Rockford, Ill. today for Bulletin 501.

British Columbia Forest Products Ltd.—one of the largest, fastest-growing timber producers in Canada—has built a reputation for efficient operation . . . continually striving for better methods and maximum performance from powered equipment. For their newest logging trucks (3 Kenworths, 8 Hayes) they specified Twin Disc Model DF Truck-Type Torque Converters . . . for from thousands of hours' experience on yarders and loaders, they know how Twin Disc Torque Converters reduce downtime and maintenance by eliminating engine lugging and shock-loading.

At the B. C. Forest Products Ltd. Harris Creek operation, loads go up to 20,000 board feet; grades are up to 20%, and footing varies continually from changing weather. But with Twin Disc *built-in* Braking, drivers are coming down under full load in second with practically *no* truck pedal-braking; with trucks under *complete* control; and *without* shock-loading transmissions. Through the powerful torque multiplication (up-to-6:1), the Cummins Diesels are pulling away more easily under load at near-governed rpm than they did *formerly*, with *mechanical* drive, at 1200 rpm. And the Model DF's Lock-Out Drive feature permits maximum economy on long, continued grades.

*Throughout* the logging industry, Twin Disc Truck-Type Torque Converters are *putting more horsepower to work*, and *providing outstanding savings on tires, brakes, axles, engines and final drives.*

TWIN DISC

**TWIN DISC**

***Torque Converters***

TWIN DISC CLUTCH COMPANY, Racine, Wisconsin • HYDRAULIC DIVISION, Rockford, Illinois

Branches or Sales Engineering Offices: Cleveland • Dallas • Detroit • Los Angeles • Newark • New Orleans • Seattle • Tulsa

## New Members Qualified

continued

Benjamin B. Phelps (M), Forrest Kenneth Poling (A), William E. Powell (M), Carl Reynolds (M), Donald D. Roberts (J), Duane H. Rofe (M), Walter L. Shepherd (M), Robert H. Skingley (M), George P. Smith (J), Kenneth L. Wheeler (M).

**Hawaii Section**

John F. Cross (A), Elmer R. Williams (A).

**Indiana Section**

Lawrence P. Mamos (J), Karl M. Sharp (J), M. V VanKirk (M).

**Metropolitan Section**

Seymour Adler (J), Joseph P. Finelli (M), Norman Kasschau (J), Joseph V. Miccio (M), Richard Opsahl (J), William H. Peters (M), George Paul Werber (J), Charles J. Wilde (M).

**Mid-Continent Section**

David A. North (M).

**Mid-Michigan Section**

Philip J. Passon (J).

**Milwaukee Section**

Donald A. Anderson (M), Arden C. Degner (J), Earl J. Kliemann (A).

**Mohawk-Hudson Section**

Loren P. Neff (M).

**Northern California Section**

Arthur R. Miser (M), Howard E. Schmitz (M).

**Northwest Section**

Glen Oscar Kerrebrock (J).

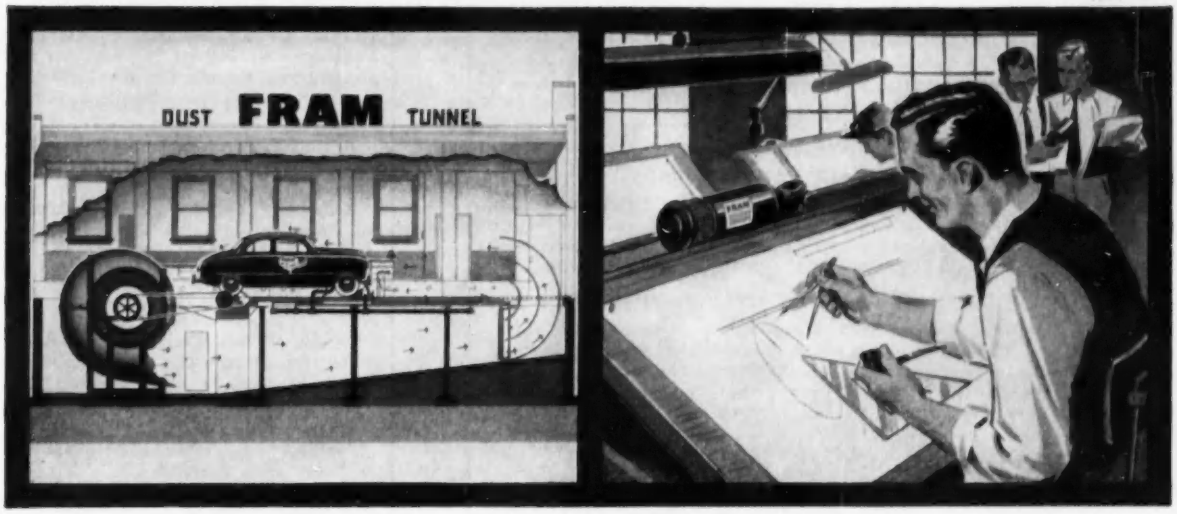
**Oregon Section**

Sam A. Battaglia (A), Richard Farnsworth (M), Arthur J. Trachsel (A).

**Philadelphia Section**

William A. McLaughlin (A), Ray H. Moore (M).

# FRAM leads the industry




## IN RESEARCH . . .

The FRAM Institute of Advanced Filter Research and Design at Dexter, Mich., is the leading research center of its kind in the world. Here, FRAM scientists and engineers study new filtration methods and materials . . . test new systems in the FRAM Dust Tunnel and in actual test-car operation. The facilities of this modern institute and the experience of its personnel are available to help you solve your filtration problems.

## IN DESIGN . . .

No other filter manufacturer matches the variety and scope of FRAM products—proof of FRAM'S leadership in design. FRAM engineers also work closely with automotive manufacturers in designing special filter systems to exact automotive specifications and requirements. Whatever your filtration needs in . . . oil, fuel, air or water . . . consult FRAM.

**FRAM**
**OIL • AIR • FUEL • WATER**
**FILTERS**

Write:
FRAM CORPORATION,
Providence 16, R.I.

From Canada Ltd.,
Stratford, Ont.

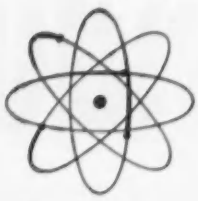
Engineers! Scientists!

**UNLIMITED OPPORTUNITIES IN**

**Atomic Power**

**AT**

Westinghouse



In a new plant on the outskirts of Pittsburgh, Pa., atomic energy will be explored as a source of power for transportation and industry.

Opportunities in this new field are unlimited for:

**MECHANICAL ENGINEERS**

Fluid flow, heat balance, valves, mechanical and hydraulic devices and mechanisms, design and application of high pressure piping and systems, heat transfer, rotating machinery, general steam apparatus and steam power systems.

**ELECTRICAL AND CONTROL ENGINEERS**

Development, design and application of control systems and apparatus for nuclear plants. This includes servo analysis, application of analog computers, functional and operational analysis of mechanical and electrical power systems and the application of temperature, pressure, flow instruments, nuclear instruments, motor controllers, regulators, control panels and special electrical controls.

**PHYSICISTS**

Basic reactor physics, reactor design and analysis, control systems, and experimental testing.

**METALLURGISTS**

To conduct basic research in physical metallurgy, corrosion and radiation effects on metals; applied research and development on materials and processes for reactor components in the field of vacuum induction melting, ceramics, powder metallurgy, welding, metal working and non-destructive inspection.

**Openings also exist for Chemical Engineers, Chemists, Radio Chemists and Dynamic Analysts.**

**SALARIES**

Open. Ample housing available. Benefits include a hospitalization-insurance program, and graduate study under the Westinghouse program at company expense.

**HOW TO APPLY**

United States Citizenship is required!

Send resume concerning your experience and education to:

**Mr. C. F. Stewart, Atomic Power Division,**
**Westinghouse Electric Corporation**
**P.O. Box 1468, Pittsburgh 30, Pa.**


## New Members Qualified

continued

**Pittsburgh Section**

Robert E. Corbett (J).

**St. Louis Section**

Clifford A. Statler (J).

**San Diego Section**

James E. Belden (J), Alan M. Dale (J), Billy Dean Newbery (J), Evan M. Ogden (J), Donald E. Roberts (J), George W. Smith, Jr. (M).

**Southern California Section**

Richard S. Bandy (A), Donald J. Brewster (J), Ernest D. Bunderson (J), Howard John Feichtmann (A), Paul D. Koger (M), Robert F. Peterjohn (J), John Louis Reynolds (M), Lawrence Leslie Saunders (J), Frank J. Ziegel (M).

**Southern New England Section**

Esmond F. Bernier, Jr. (M), Edward W. Dwyer (J), Robert W. Lorimer (J), Joseph G. Maceyka (M).

**Texas Section**

Frank Wilbur Davis (M), Edward Enns (A), Andrew G. Lontai (A), Robert I. Michaelson (M), Joe Willmon (A).

**Texas Gulf Coast Section**

Jack K. Gilbert (J), J. B. Godwin, Jr. (J), Mark K. Wallach (A).

**Washington Section**

2nd Lt. Thomas J. Cribbs (J), Reginald Whitson (A).

**Williamsport Section**

W. H. Lorimer (A).

**Outside Section Territory**

Stuart Allen Cameron (J), David T. Geddis (J), Robert E. Henderson (M), Donald J. Horkan (M), Lowell Paul Martin (J), John A. Marvin (M), William Frank Schmeling (M), William A. Trace (J), John Geoffrey Trotter (J), Earl Eugene Wellborn (J).

**Foreign**

Arthur Robert Burton (M), Australia; Clyde William Campbell (M), Germany; Jefferson Woolf Mitchell (M), Iraq; G. Peter Wood (M), England.

# *When the "specs" call for specials*

# . . . put a specialist on your team

Backed by nearly forty years of experience in designing special bearings and parts for volume production, our engineers can be of real assistance to your own design department . . . can assure you the consistent quality and extreme uniform accuracy that speeds assembly, cuts costs, improves product performance and service life.

Aetna's skill in the economical mass production of specials—of the general type illustrated here—explains why so many of America's great manufacturers find it profitable to work with Aetna. They know that Aetna, through the years, has geared its abilities and facilities, its design, engineering and manufacturing functions for maximum cooperation with manufacturers of mass-produced products.

Add up the advantages and you'll see why it will pay you, too, to put your special bearing and parts problems up to Aetna. Your inquiry will receive our immediate attention.

**Aetna**

BALL AND ROLLER BEARINGS
MISCELLANEOUS PARTS

*Quality since 1916*

**Aetna Ball and Roller Bearing Company**
DIVISION OF PARKERSBURG-AETNA CORPORATION
4600 SCHUBERT AVENUE • CHICAGO 39, ILLINOIS
In Detroit: SAM T. KELLER • 2457 Woodward Avenue • WOodward 1-2040

## Applications Received

The applications for membership received between February 10, 1955 and March 10, 1955 are listed below.

**Atlanta Section**

Robert Brown, Arthur A. Kizer.

**Baltimore Section**

William R. Strong.

**Buffalo Section**

George J. Persico.

**Canadian Section**

P. A. Courage, Samuel Schacter, Keith J. Warren.

**Central Illinois Section**

R. Rex Burnett, Kenneth R. Moline.

**Chicago Section**

Walter E. Arens, Joseph A. Bascle, Jr., Warden T. Blair, Jr., Richard Chrzanowski, Robert H. Dawson, Walter A. Forrest, John H. Freeman, Jr., K. E. Grundvig, Joseph P. Meli, Andrew A. Naleway, Jr., Harold E. Pickles, Robert F. Potteiger, John C. Schneider, Marvin F. Schobert, P. A. Taileffer.

**Cincinnati Section**

George E. Fouch, Guy C. Shafer, John B. Silverwood.

**Cleveland Section**

Clarence H. Culler, Howard T. Griffith, Jr., William S. McCormick, Jr., George W. Price, Robert E. Schmitt, William Tebbel, Stephen P. Uhlik, Robert C. Wattleworth.

**Colorado Group**

George Shellenberger.

**Dayton Section**

David R. Fleming, Walter G. Kniffin, Jr.

**Detroit Section**

Thomas H. Bartlett, Arthur W. Bear, Edwin J. Durand, Adolf Egli, Dan D. Epps, James P. Falvey, George C. Forsyth, Jr., J. T. Galvin, Bernard G. Golden, Charlton O. Goodykoontz, Paul R. Jones, Jack O. Lefton, Henry C. Maskey, Wayne H. Mueller, Milford E. Prather, Robert H. Pylkas, Edward Redmond, Paul A. Ribaux, Richard M. Saxby, William W. Vincent, Wylie J. Voorheis, Calvin G. Wells, William Weightman, Henry J. Wezner, Norbert P. Worden.

**Hawaii Section**

Jack Q. Blades.

**Indiana Section**

Basil G. Bentz, Leland E. Boren, Robert L. Floyd, Percy L. Ford, Oliver T. Nephew.

**Kansas City Section**

T. Nicholas Bath, John L. Jones, Robert L. Wells.

**Metropolitan Section**

Sam E. Fast, Robert N. Hagarty, Vincent A. Hines, Park Wheeler Judah, Joseph R. Lejk, William E. Lifson, Charles Milak, John D. Miller, Raymond Petretti, Edmund M. Storer, Jr., Earl A. Venstrom.

**Mid-Michigan Section**

Gunnar J. Anderson, Richard R. Crockett, Max Phillips, Russell K. Welch.

**Milwaukee Section**

William R. Bryant, R. L. Burks, William F. Danner, John N. Eckroth, Harold F. Pokorney.

**Montreal Section**

Lennox L. Joseph, Reginald A. Wardle.

**New England Section**

Frank Cragg, Albert L. Morris.


# New TUNG-SOL All-Glass Sealed Beam VISION-AID HEADLAMP

IMPROVED BEAM PROVIDES BETTER VISIBILITY

VISION-AID HEADLAMP is the most powerful and the safest headlamp ever developed. Light output has been increased by raising the lower beam wattage from 35 to 40 and the upper beam from 45 to 50 watts.

VISION-AID HEADLAMP provides 23 per cent more light on the low beam and 26 per cent more light on the high beam.

VISION-AID HEADLAMP projects the passing beam up to 80 feet farther ahead, but more to the right, at the same time reducing the amount of light directed toward an approaching vehicle.

VISION-AID HEADLAMP produces less uncontrolled light, thereby reducing the light reflected back at the driver from fog, rain, dust or snow encountered in bad weather.

**TWO TYPES**
**5040 for 6 volts**
**5400 for 12 volts**

**TUNG-SOL ELECTRIC INC., Newark 4, N. J.**

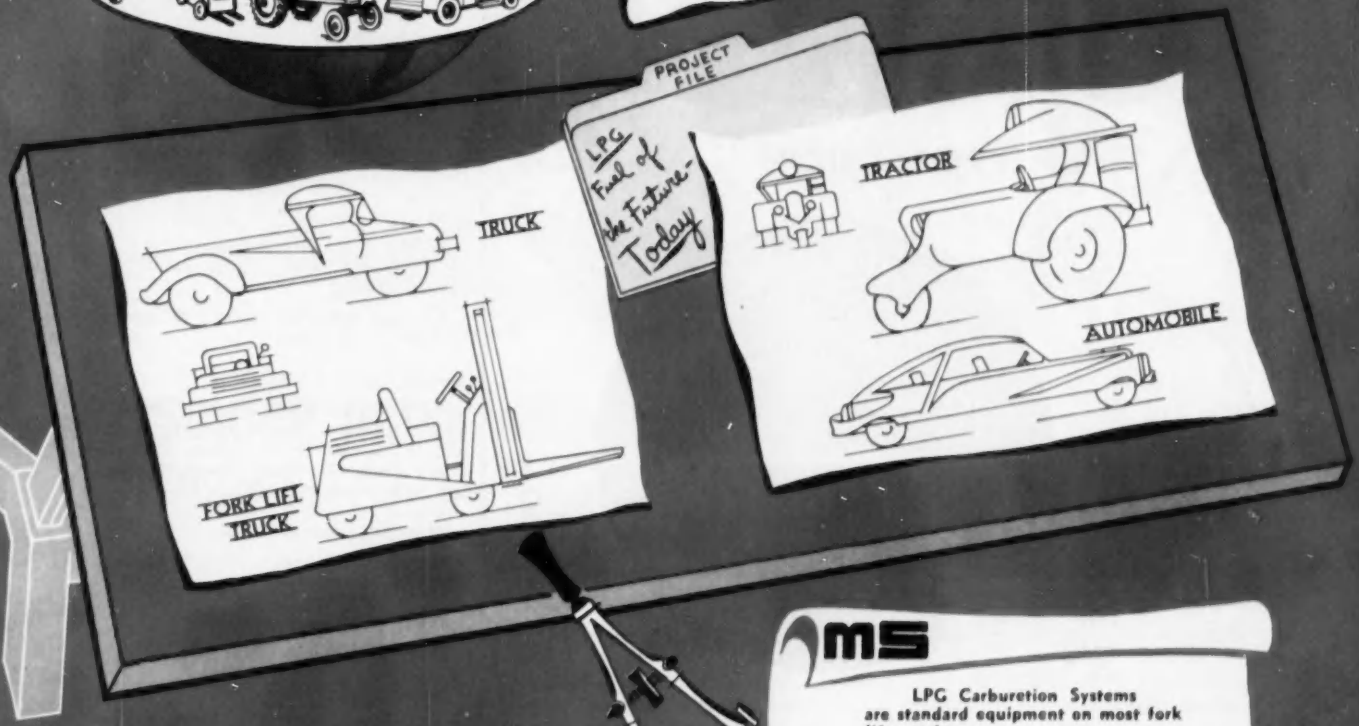
Sales Offices: Atlanta, Chicago, Columbus, Culver City (Los Angeles), Dallas, Denver, Detroit, Newark Philadelphia, Seattle.
Tung-Sol makes All-Glass Sealed Beam Lamps, Signal Flashers, Picture Tubes, Radio, TV and Special Purpose Electron Tubes, and Semiconductor Products.

MARVEL-SCHEBLER'S

HALF CENTURY OF

# CARBURETION "KNOW-HOW"

IS SOLVING LPG ENGINEERING PROBLEMS TODAY!




## MS LPG Carburetion Systems

FOR TRACTORS, TRUCKS, PASSENGER CARS AND FORK-LIFT TRUCKS

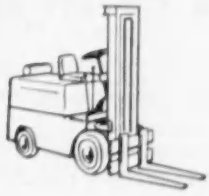
For almost half a century, Marvel-Schebler engineers have been called upon to help solve your carburetion problems. Today, with more and more engines being designed exclusively for LPG operation, experienced Marvel-Schebler engineers are at your service. Complete LPG testing equipment, including accurate dynamometer reports are available to you. Whatever the application, Marvel-Schebler has the facilities to fit the need!

Gasoline Carburetors For Tractor, Aircraft and Industrial Engines

Power Brakes For Passenger Cars and Trucks

MS

LPG Carburetion Systems are standard equipment on most fork lift trucks . . .



CLARK

TOWMOTOR

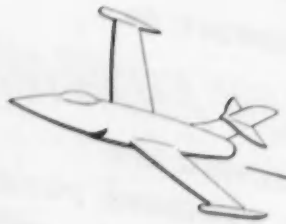
HYSTER

MS MARVEL-SCHEBLER Products Division

BORG-WARNER CORPORATION · DECATUR, ILLINOIS

BW

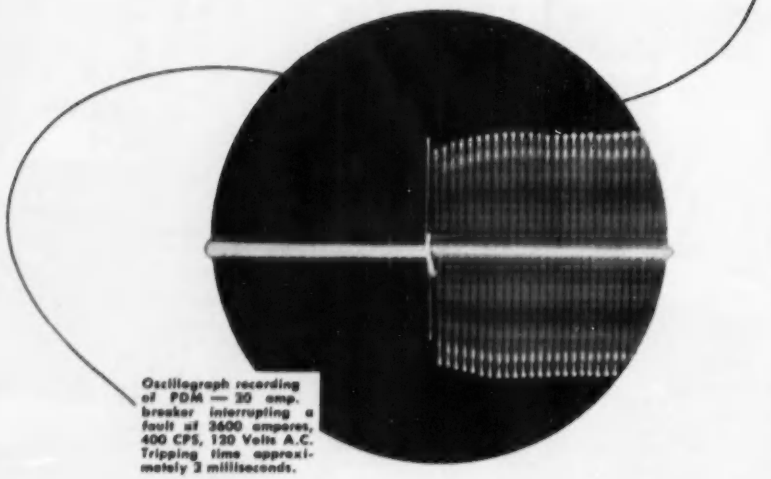
For a completely equipped and expertly staffed research laboratory for power brake, LPG and gasoline carburetor development . . . plus trained engineering field men to assist you . . . call Marvel-Schebler!



SMALL . . . BUT

# GIANTS

OF PROTECTION



Oscillograph recording of PDM — 30 amp. breaker interrupting a fault of 3600 amperes, 400 CPS, 120 Volts A.C. Tripping time approximately 3 milliseconds.

## KLIXON Circuit Breakers

- Completely sealed — truly explosion proof.
- Small in size — approximately as big around as a half dollar.
- Light in weight — only 1.7 oz.
- Shockproof — withstand up to 100 G's.
- Precision Calibration — calibrated to limits 115–125%, one-half as wide as AN limits (115–138%).
- Exceptionally high resistance to vibration, moisture and corrosion.

PDA Automatic Reset Ratings 10 to 40 Amps

PDM Manual Reset Ratings 15 to 40 Amps

Write for complete data on these and other Klixon protection-proved Circuit Breakers.

KLIXON

METALS & CONTROLS CORPORATION
SPENCER THERMOSTAT DIVISION
1504 FOREST STREET, ATTLEBORO, MASS.


## Applications Received

continued

**Northern California Section**

John Richardson Barber, Elmore Kittower, Arthur L. Lyman, Lawrence A. Patrick.

**Oregon Section**

William D. Copps, James K. Tanner.

**Philadelphia Section**

Thomas P. Demuth, Ralph M. Hill, Vernon W. Johnson, Jr., George M. Powell, Jr.

**Pittsburgh Section**

Philip S. Marinkovich.

**St. Louis Section**

Alexander P. Fox, Robert W. Keller, Gerald C. Maechler.

**Southern California Section**

Robert A. Almquist, Paul E. Beattie, Ichio Egashira, Earl L. Hodson, Richard W. Larkin, R. H. Luke, Jack D. Rigby, Homer T. Seale, Joseph E. Stanley, Stanton F. Wiswell.

**Southern New England Section**

Donald G. Brubaker, John H. Cowles, John V. Matejkovic.

**Spokane-Intermountain Section**

Russell J. Pohl.

**Texas Section**

Farrald G. Belote, Sr., Jack Joerns, Arthur J. Smith.

**Texas Gulf Coast Section**

F. W. Brizzolara, Wilbur H. Cooper, Morris R. Morrow, R. B. Tuggle, Edward F. Wadley.

**Twin City Section**

Martin P. Kloet.

**Virginia Section**

Elwood C. Orrell, Jr.

**Washington Section**

Wilbur P. Lamb, Herman P. Simon.

**Outside of Section Territory**

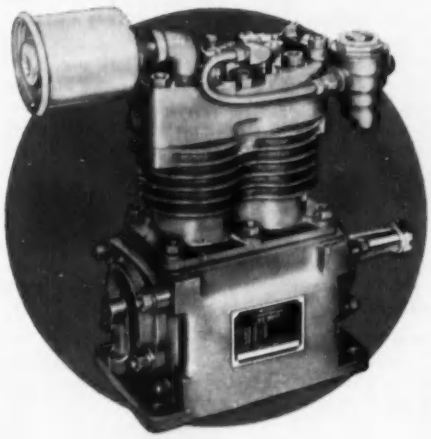
James Broemer, Richard E. Doerfer, Kenneth R. Harman, James Ray Harvey, George L. Henwood, Stanley D. Liedtke, Ernest J. Richards, John C. Rundell, Edmund V. Wesely.

**Foreign**

Oswald E. Boll, Switzerland; Clarence Hoogerwerf, Holland; Sami M. Kazes, France; Jacques Y. Levoyer, France; Jagat N. Malik, India.

# "150,000 Miles without an overhaul... You just can't beat a MIDLAND Compressor!"

**"Smartest thing the boss ever did was standardize on Midland Compressors. Never any oil pumping with them...and man, the miles of good performance they turn in without an overhaul!"**



***That's Right***—Midland Compressors are known by truck and bus operators the world over for their positive, economical performance and their ability to really take it for thousands and thousands of miles without the need for servicing. Midland Compressors give you these big advantages:

***Greatest Efficiency***—Due to patented automatic inlet valves built into cylinder head.

***Minimum Oil Consumption***—Due to lack of high vacuum on suction stroke.

***Cooler Operation***—Because inlet valves let atmospheric air circulate through compressor when idling, practically eliminating carbon.

***Integral Governor***—Governor mounted on compressor simplifies installation.

***Less Weight***—A very important factor for today's operators.

***Reduced Maintenance***—Lack of compressor oil pumping greatly reduces maintenance due to elimination of oil and varnish deposits throughout the entire brake system.

◆ ◆ ◆

For complete details, see your nearest Midland dealer—or write factory direct.

**MIDLAND** STEEL PRODUCTS COMPANY

3641 S. Milwaukee Ave. • Detroit 11, Michigan

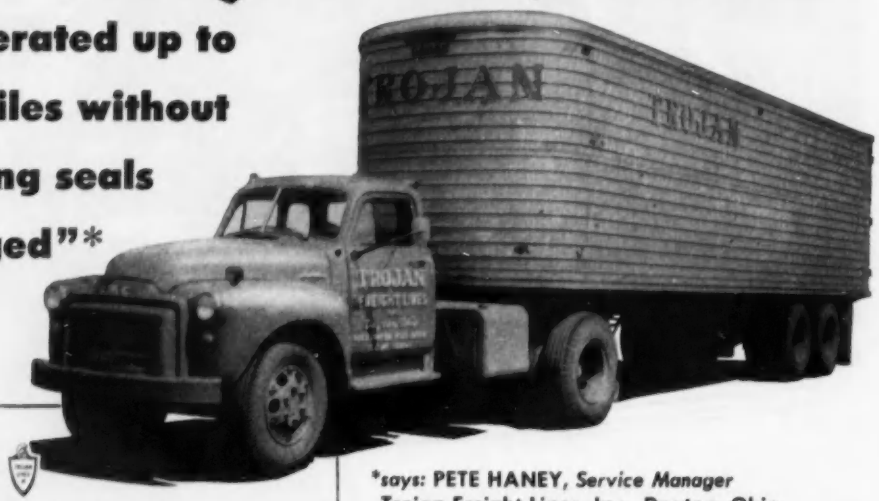
Export Department: 38 Pearl Street, New York, N. Y.

*Those Who Know Power Brakes*

**CHOOSE MIDLAND!**

# "Wagner Rotary Air Compressors

## ...have operated up to 550,000 miles without even needing seals to be changed"*




**TROJAN FREIGHT LINES, INC.**
1335 DALLER ST. DAYTON 3, OHIO

Wagner Electric Corporation
6400 Plymouth Avenue
Saint Louis 14, Missouri

Dear Sirs:

Our drivers log a lot of miles hauling throughout Ohio and Indiana. To provide maximum safety and to give customers 'on schedule' service, I make absolutely sure that the power equipment in our fleet is kept in perfect running condition.

The Wagner 'Air-Over-Hydraulic' Brake Systems installed in our fleet have given us very fine service. I especially like Wagner Rotary Air Compressors. They are easy to install and service, quiet in operation and definitely keep air lines free of carbon and sludge formation. They have a long service life—in fact some of the Wagner Rotary Air Compressors have operated up to 550,000 miles without even needing seals to be changed. I also think your compressors have the fastest air pressure recovery and are extremely economical to service and maintain. They reduce road failure, too, because they are dependable.

We plan to specify Wagner Air the next time we order new power units for our fleet.

Very truly yours,
Pete Haney
Pete Haney
Service Manager

Ftca

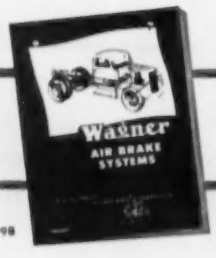
***says: PETE HANEY, *Service Manager***
**Trojan Freight Lines, Inc., Dayton, Ohio**

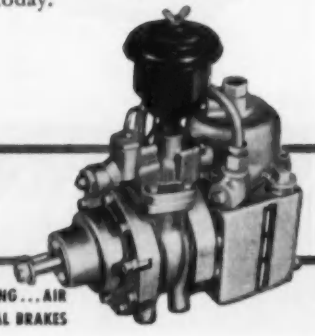
Profit-minded trucking companies, like Trojan Freight Lines, Inc., have been quick to realize the absolute dependability of WAGNER AIR BRAKES. This year, many other trucking firms will gain the same freedom from maintenance worries, will cut costly repair jobs and increase driver-equipment-cargo safety by standardizing on WAGNER AIR.

WAGNER ROTARY AIR COMPRESSORS—standard on all WAGNER AIR BRAKE SYSTEMS—have these outstanding features: *Rotary motion*—to keep friction loss low and operating efficiency high . . . *Oil separation and cooling before air is discharged from the compressor*—to reduce the air temperature and prevent carbon formation in air lines. And because of the proven record of long parts-life, costly down time due to failures or repairs is kept at a minimum. WAGNER AIR BRAKES will save money for any fleet operation, regardless of size.

Because of the ever-increasing demand for greater road and cargo safety and maintenance economy, it will pay you to include Wagner Air Brakes as standard equipment on the vehicles you manufacture.

Send for your free copy of Wagner Bulletin KU-201 for full information and complete details. It will be sent to you without cost or obligation. Mail your request, today.



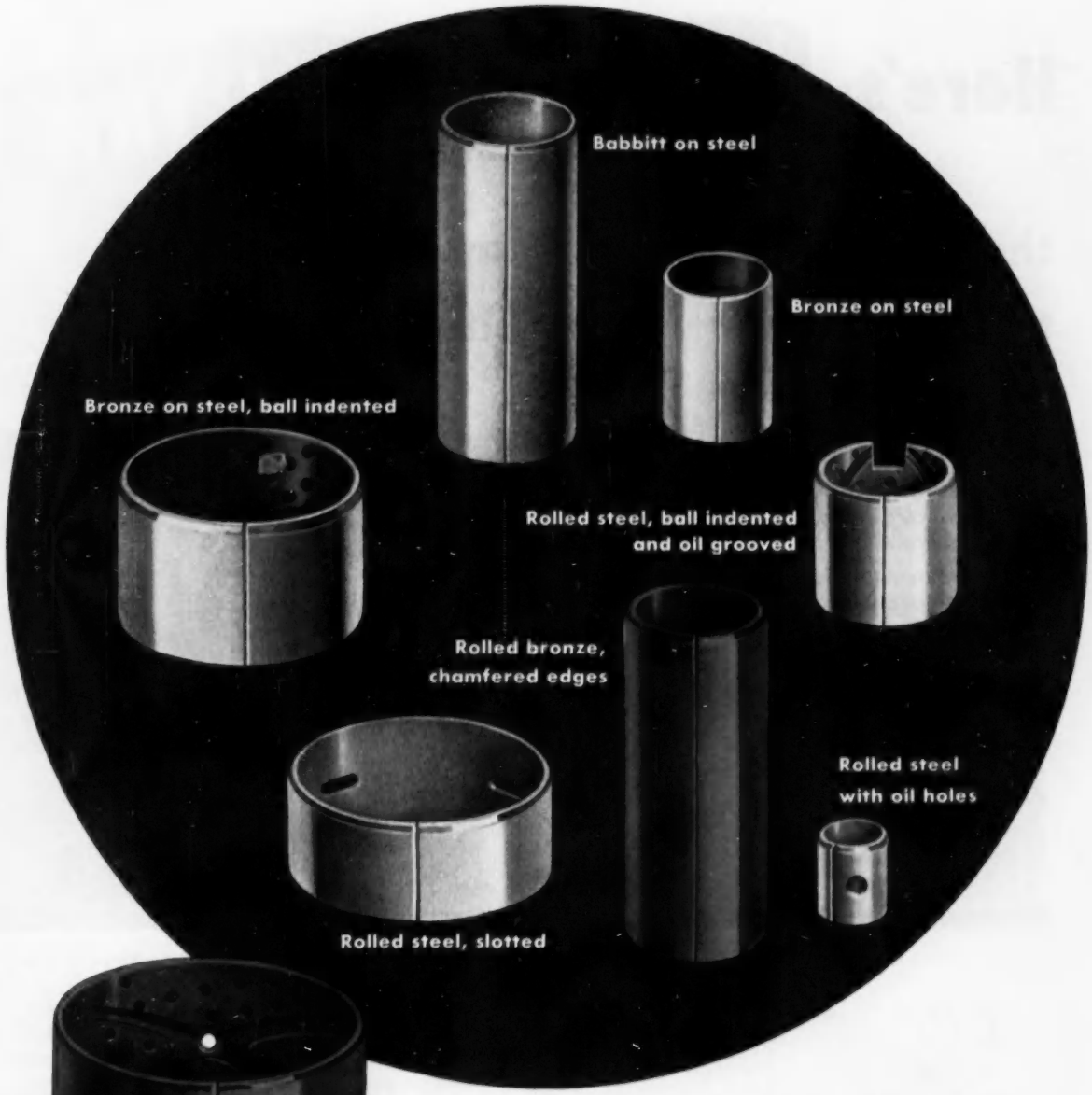



**WAGNER AIR BRAKE USERS**
**ARE OUR BIGGEST BOOSTERS**

**Wagner Electric Corporation**
6378 PLYMOUTH AVENUE • ST. LOUIS 14, MO., U. S. A.
(Branches in Principal Cities in U. S. and in Canada)

K55-98

LOCKHEED HYDRAULIC BRAKE PARTS and FLUID . . . NoRol . . . CoMoX BRAKE LINING . . . AIR BRAKES . . . TACHOGRAPHS . . . ELECTRIC MOTORS . . . TRANSFORMERS . . . INDUSTRIAL BRAKES


Babbitt on steel
Bronze on steel
Bronze on steel, ball indented
Rolled steel, ball indented and oil grooved
Rolled bronze, chamfered edges
Rolled steel with oil holes
Rolled steel, slotted

Rolled, split bushings, bimetal or plain, are real money savers. Bimetal bushings give bearing performance at bushing costs for many applications. Plain bushings save money in hundreds of uses from business machines to bicycles. Both types available in a wide variety of sizes, with oil holes, grooves, notches, windows, straight, lock or special seams. Quality control. Engineering service.

**FEDERAL-MOGUL CORPORATION, 11035 Shoemaker, DETROIT 13, MICHIGAN**

FEDERAL Mogul since 1899

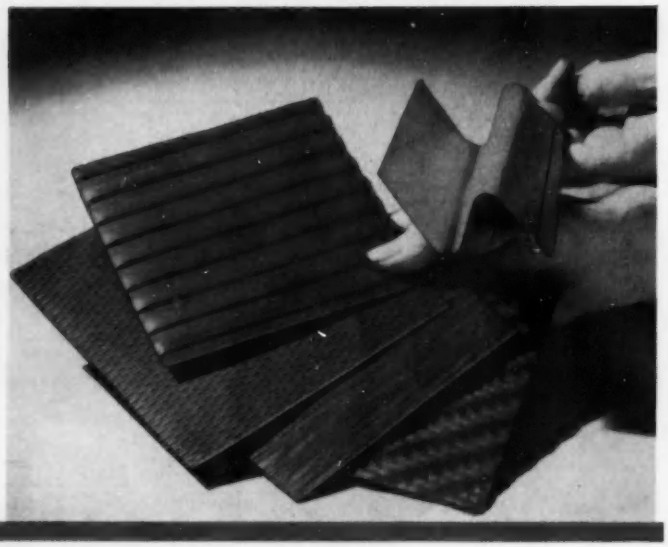
# FEDERAL-MOGUL

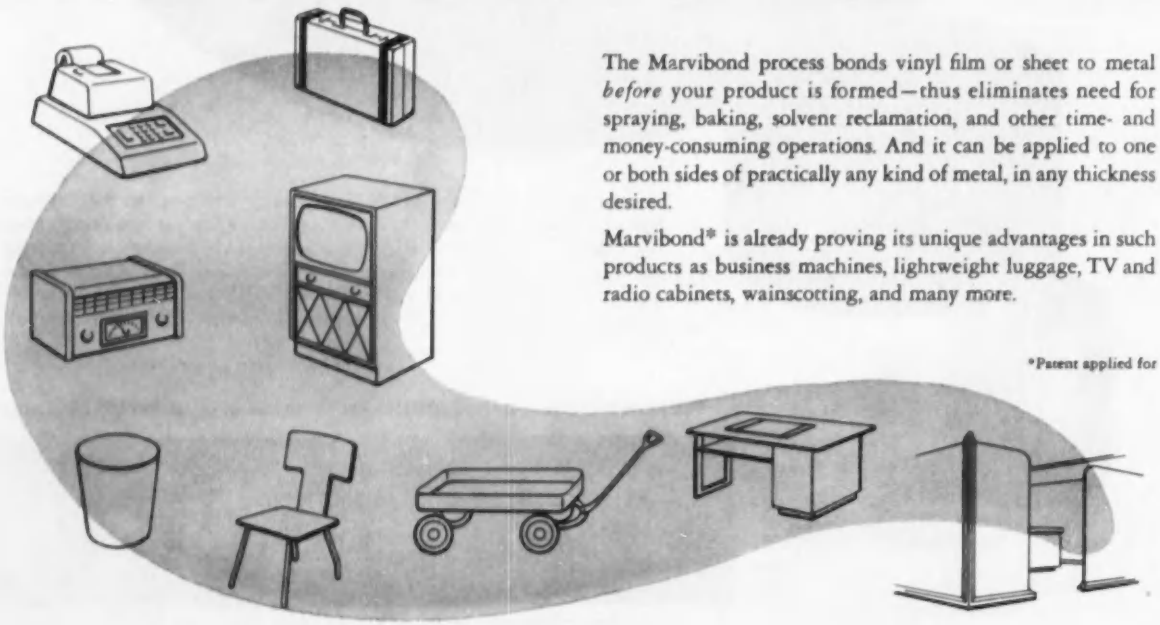
**Also sleeve bearings in many designs and sizes; cast bronze bushings; washers, spacer tubes, precision bronze parts and bronze bars.**

# Here's Marvibond

## the new vinyl-to-metal laminating process that gives sheet metal all these advantages . . .

- **outstanding protection against rust and corrosion!** One of the most inert of all known materials, vinyl resists acids, alkalies, salt water, alcohol, household chemicals, corrosive industrial liquids and atmospheres.
- **lastingly beautiful surface effects!** Vinyl can be given practically any color, in many finishes, leather-like grains, marble patterns, prints, weave-like designs.
- **superior abrasion resistance!** Marvinol® vinyl resists abrasion far better than paints, lacquers, varnishes, phenolic or alkyd finishes, will not chip, crack or craze.
- **great utility!** Marvibonded metal eliminates costly finishing operations—can be drawn, crimped, sheared, embossed, and otherwise formed *without damage to coating or bond.*





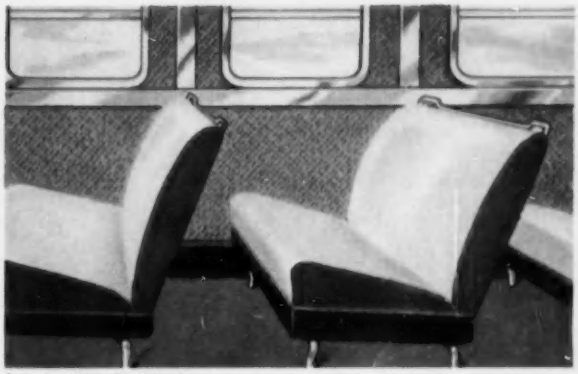
The Marvibond process bonds vinyl film or sheet to metal *before* your product is formed—thus eliminates need for spraying, baking, solvent reclamation, and other time- and money-consuming operations. And it can be applied to one or both sides of practically any kind of metal, in any thickness desired.

Marvibond* is already proving its unique advantages in such products as business machines, lightweight luggage, TV and radio cabinets, wainscotting, and many more.

*Patent applied for

# WHY NOT Marvibonded

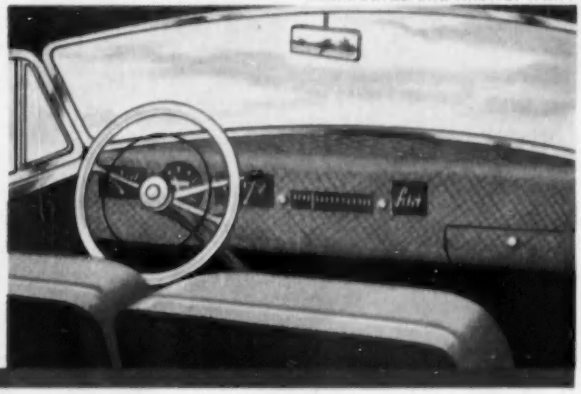
trunk compartments?



bus interior linings?

truck cab interiors?

dashboards and interior trim?



**Trunk compartments** lined with Marvibonded steel would protect luggage—and be protected *against* luggage, cans, and other cargo. They could be easily washed clean. And they might even be designed to carry out the motif of the passenger compartment itself.

**Truck cab interiors** of this same material would be clean and comfortable looking—and easy to keep that way. They'd be tough enough for the roughest drivers. And they'd resist rust, oils, gasoline, road grime, and most chemicals for *lasting* service.

**Bus linings** of tough Marvibonded metal would be strong enough to resist "break-through", would not scratch easily, and could be finished to match seat covering materials. They'd provide years of lining beauty, at low weight, *and* at low cost.

**Dashboards and interior trim** of Marvibonded metal would be richly attractive, glare-free, and always pleasant to the touch. They'd fight off scratches far better than paint. And they could be selected to match or harmonize with the rest of today's bright interior finishes.

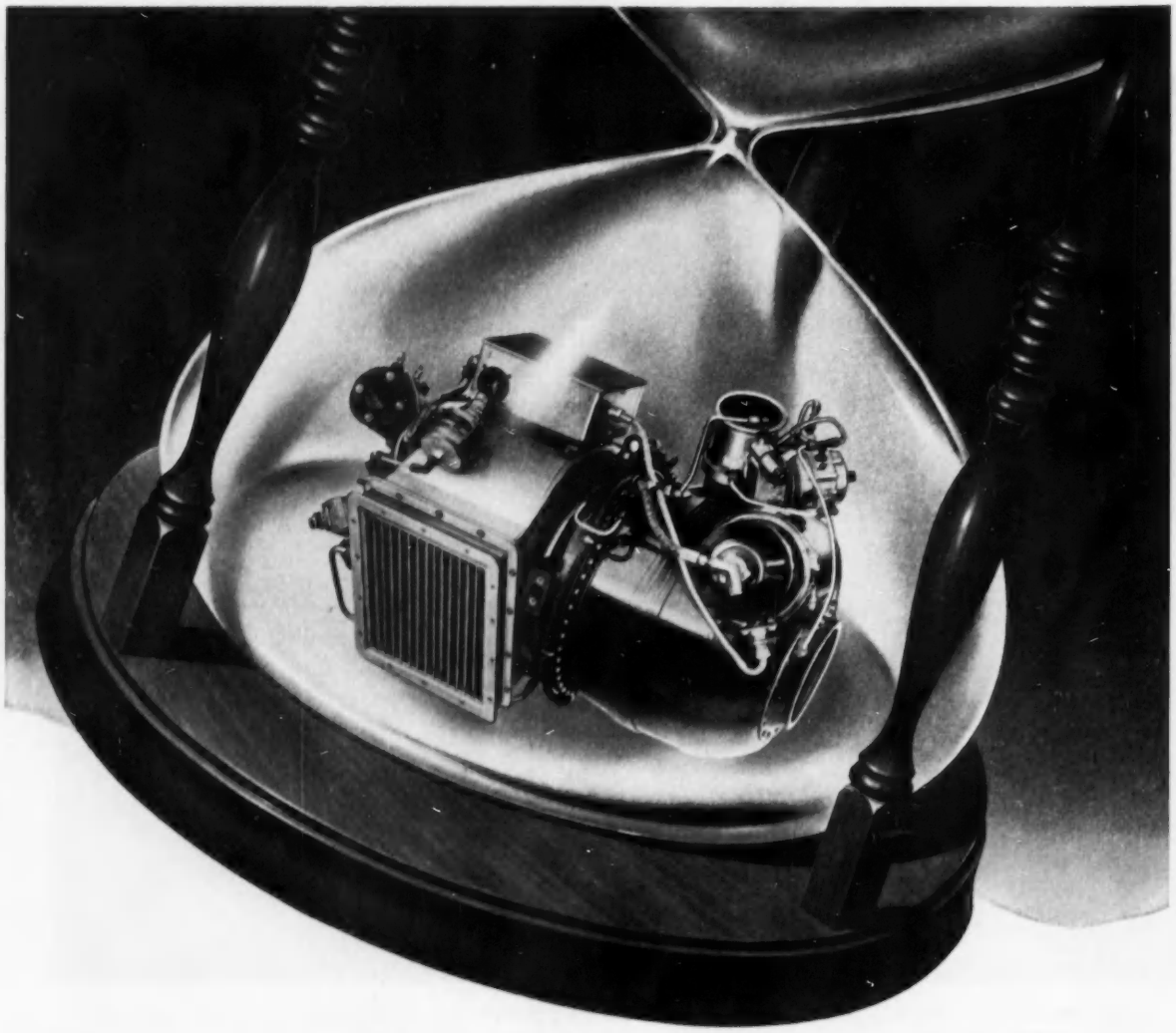
**Why not** Marvibond for these or the many other applications where Marvibond's beauty, permanence, and relatively low cost can be a distinct advantage in *your* manufacturing operations?

For product improvement, added sales impetus, and production economy, you'd better investigate Marvibond today. Simply write to the address below.

## Naugatuck Chemical

Division of United States Rubber Company
Naugatuck, Connecticut

BRANCHES: Akron • Boston • Charlotte • Chicago • Los Angeles • Memphis • New York • Philadelphia • IN CANADA: Naugatuck Chemicals, Elmira, Ontario
Rubber Chemicals • Synthetic Rubber • Plastics • Agricultural Chemicals • Reclaimed Rubber • Latices • Cable Address: Rubexport, N.Y.



# Small gas turbines pass test of time

***New Milestones Gain Industry-wide Acceptance for AiResearch Power Turbines***

AiResearch small gas turbine engines, first of this revolutionary class of turbomachinery to be developed, have now passed the following important milestones:

• 100,000 hours of actual service in the field • Successful operation up to altitudes of 53,000 feet • Completely reliable automatic control on production machines • Customer established overhaul periods of up to 600 hours on existing units • Design overhaul periods on new models of 1000 hours • All phases of military qualification (Including new shaft power and gas turbine compressor designs).

Pioneer in this field, AiResearch is first to develop and deliver combination units capable of delivering either shaft or bleed air power independently of each other. AiResearch has more experience with small gas turbines than all other manufacturers combined.

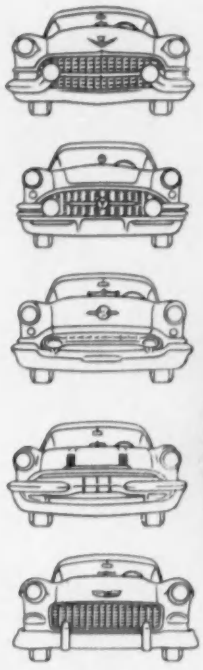
We are proud of the engineering-manufacturing team that has made possible these outstanding contributions to industry.

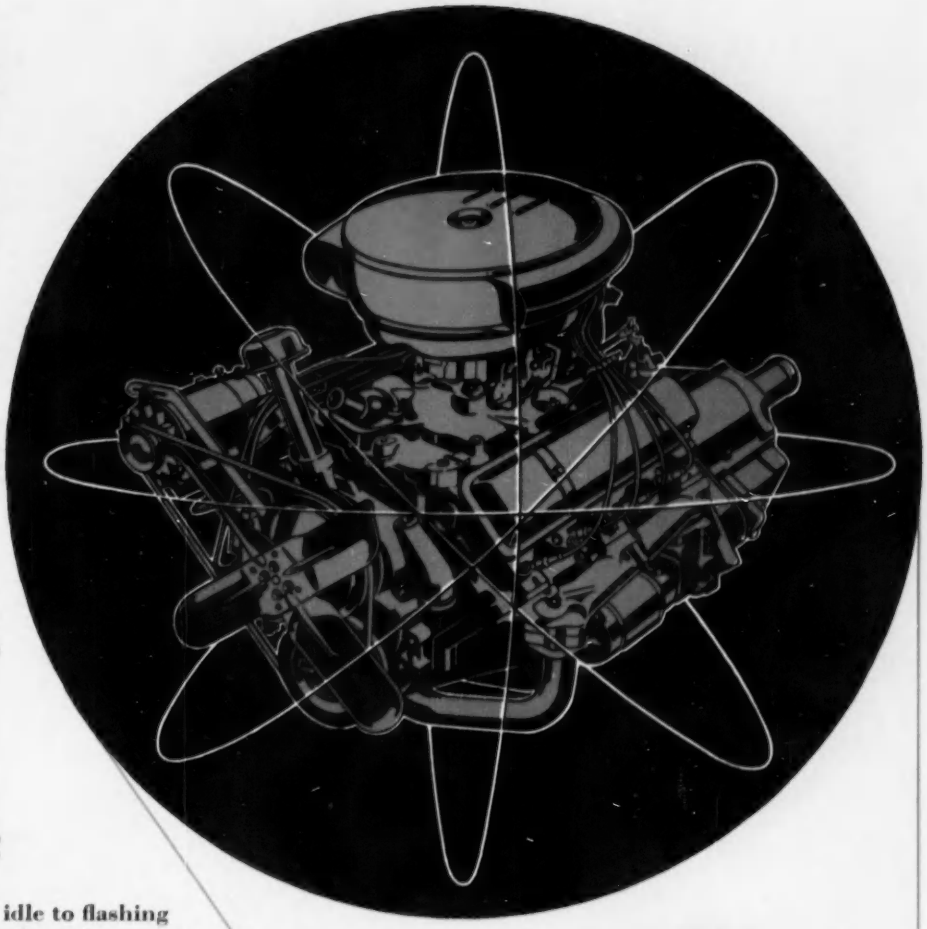
**THE GARRETT CORPORATION**

AiResearch Manufacturing Divisions

*Los Angeles 45, California • Phoenix, Arizona*

*Designers and manufacturers of aircraft components:* REFRIGERATION SYSTEMS • PNEUMATIC VALVES AND CONTROLS • TEMPERATURE CONTROLS CABIN AIR COMPRESSORS • TURBINE MOTORS • GAS TURBINE ENGINES • CABIN PRESSURE CONTROLS • HEAT TRANSFER EQUIPMENT • ELECTRO-MECHANICAL EQUIPMENT • ELECTRONIC COMPUTERS AND CONTROLS



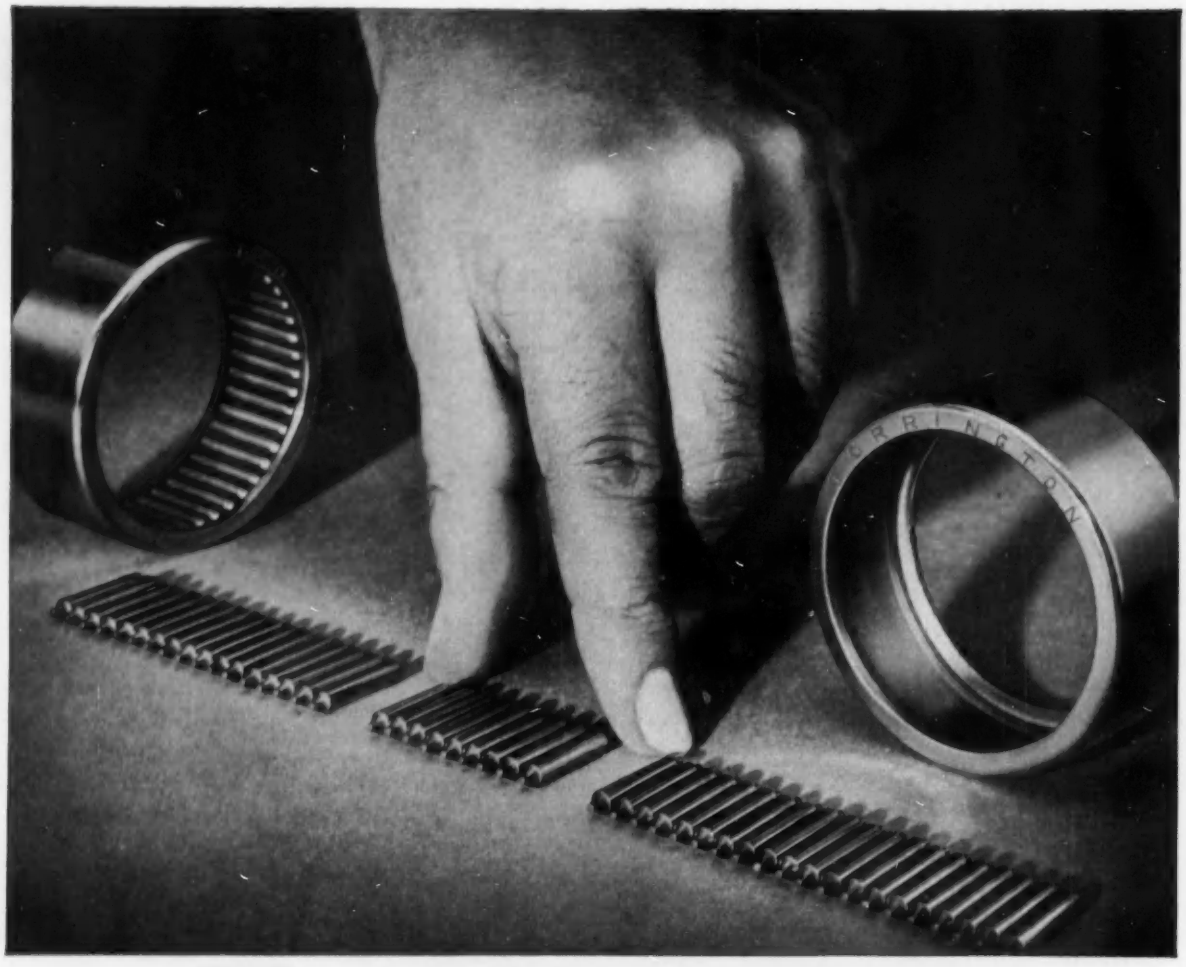


## An engine never had it so good!

From a slow, smooth idle to flashing full throttle—you can depend on your Rochester Carburetor for *top performance, top efficiency!* For every Rochester Carburetor is a perfect mixer—specially engineered to blend the *right* amount of fuel with the *right* amount of air in today's high-powered, high-performance engines. And Rochester Carburetors are rugged and versatile—outstanding performers in hot or cold weather, in tight traffic or on the wide open road. That's why Cadillac, Buick, Oldsmobile, Pontiac and Chevrolet . . . *all choose Rochester!*

# CARBURETORS BY ROCHESTER PRODUCTS

ROCHESTER
PRODUCTS
DIVISION OF
GENERAL MOTORS
CORPORATION
ROCHESTER N.Y.




# *"Here's where the* **TORRINGTON NEEDLE BEARING** *gets its high load capacity"*

The radial load capacity of an anti-friction bearing depends, in the final analysis, on the number of lines or points of contact made by the bearing surfaces in the load zone. This is where the Torrington Needle Bearing really shines.

With its full complement of precision-ground rollers, the Needle Bearing gives many more lines of contact than other types of anti-friction bearings. Thus for a given size, the Needle Bearing has a *greater* radial load capacity than other bearings.

What does this do for your product? The Needle Bearing can give you the benefits of its high-capacity performance for little more than the cost of a plain bearing; it can help you reduce the size and weight of surrounding members without sacrificing shaft strength, thickness or rigidity.

For twenty years, our Engineering Department has helped designers and manufacturers throughout industry to adapt the unique advantages of the Needle Bearing to their products. Let us help you make the Needle Bearing "standard equipment" in yours.

THE TORRINGTON COMPANY
Torrington, Conn. • South Bend 21, Ind.

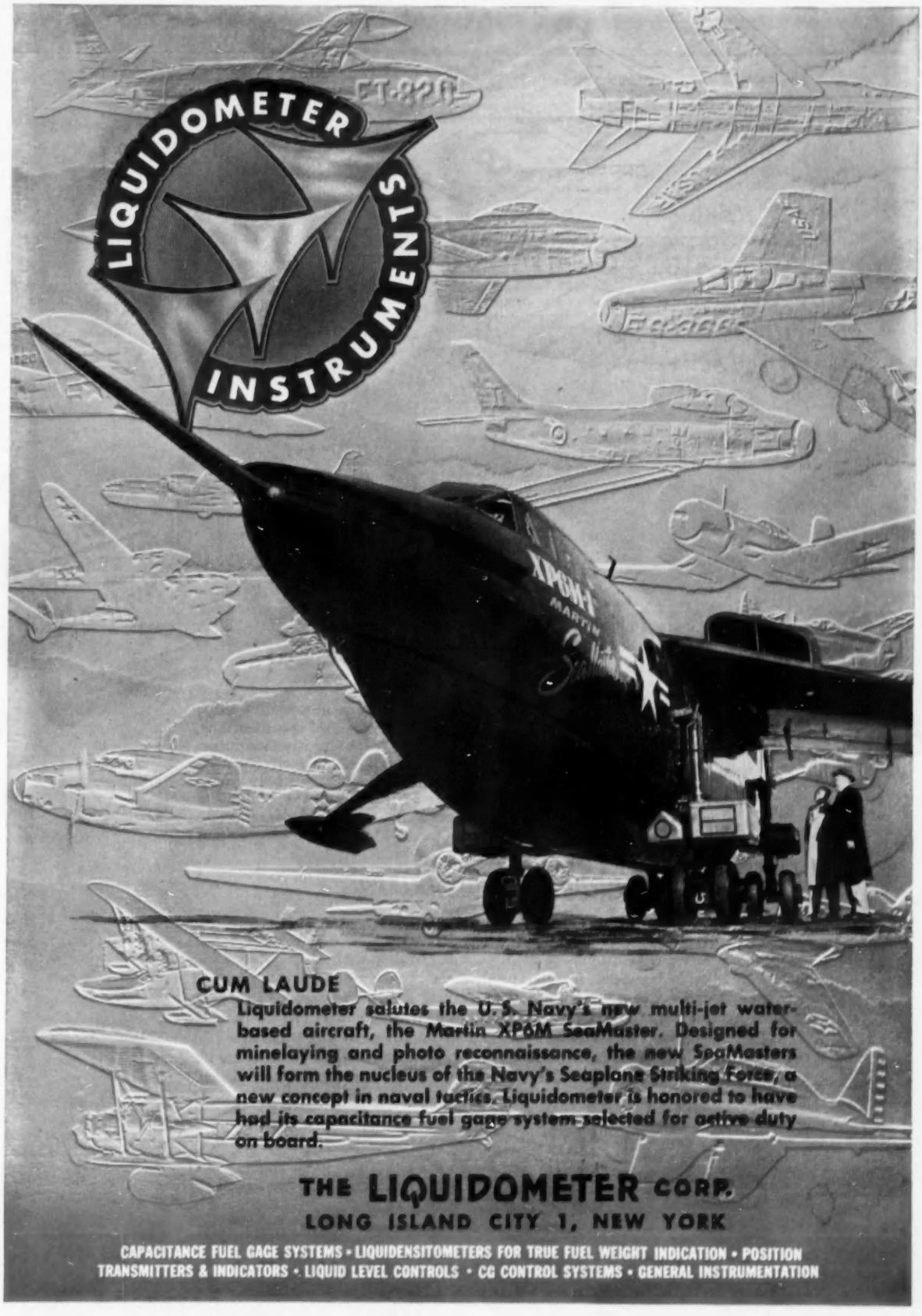
*District Offices and Distributors in Principal Cities of United States and Canada*

**TORRINGTON** *NEEDLE* **BEARINGS**

**Needle • Spherical Roller • Tapered Roller • Cylindrical Roller • Ball • Needle Rollers**

*These features make the* **TORRINGTON NEEDLE BEARING** *unique*

- low coefficient of starting and running friction
- full complement of rollers
- unequalled radial load capacity
- low unit cost
- long service life
- compactness and light weight
- runs directly on hardened shafts
- permits use of larger and stiffer shafts



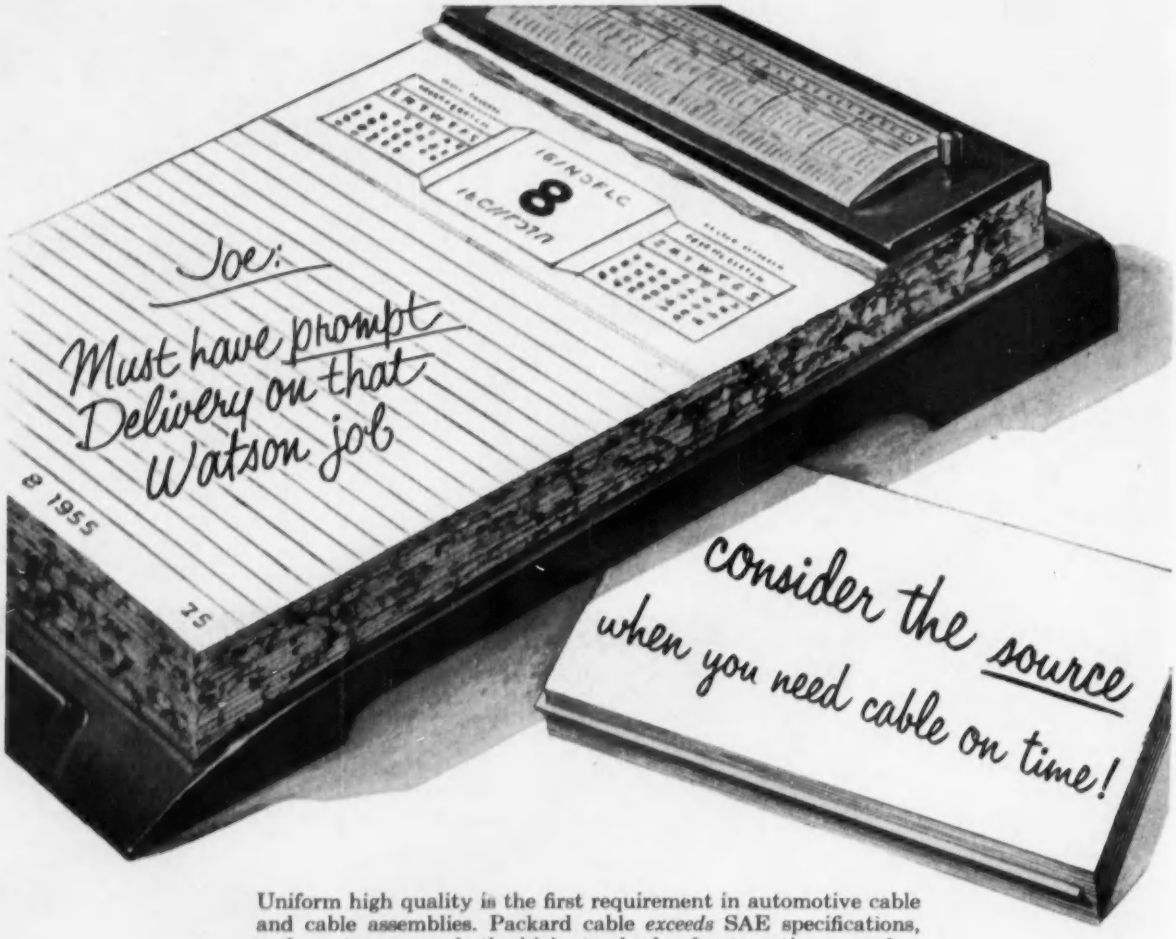

**CUM LAUDE**

Liquidometer salutes the U. S. Navy's new multi-jet water-based aircraft, the Martin XP6M SeaMaster. Designed for minelaying and photo reconnaissance, the new SeaMasters will form the nucleus of the Navy's Seaplane Striking Force, a new concept in naval tactics. Liquidometer is honored to have had its capacitance fuel gage system selected for active duty on board.

**THE LIQUIDOMETER CORP.**

**LONG ISLAND CITY 1, NEW YORK**

CAPACITANCE FUEL GAGE SYSTEMS • LIQUIDENSITOMETERS FOR TRUE FUEL WEIGHT INDICATION • POSITION TRANSMITTERS & INDICATORS • LIQUID LEVEL CONTROLS • CG CONTROL SYSTEMS • GENERAL INSTRUMENTATION




Uniform high quality is the first requirement in automotive cable and cable assemblies. Packard cable *exceeds* SAE specifications, and meets or exceeds the high standards of automotive manufacturers. But Packard's advantages go beyond quality itself. Dependable, on-time delivery that results from flexible, carefully maintained production schedules is one of many additional benefits you enjoy when you deal with Packard.

## Consider Packard as a source

When you choose Packard Electric as a source you acquire the services of an expert team that is familiar with all phases of the cable business. A daily production capacity of 7,000,000 feet of cable and more than 800,000 wiring assemblies assures unfailing delivery. And Packard's large staff of experienced engineers is at your service for expert counseling and advice at any stage of a job. In the past, benefits like these have meant big savings to many Packard customers. More than likely, they will mean the same to you.

GM GENERAL MOTORS Packard REG. U.S. PAT. OFF.

**Packard Electric Division, General Motors, Warren, Ohio**
**Offices in Detroit, Chicago, and Oakland, California**

AVIATION, AUTOMOTIVE AND APPLIANCE WIRING

*Judge a Product by its Users*

The sleek, delta wing Convair F-102A, newest Air Force all-weather interceptor, achieves supersonic speeds in level flight. Even the service and maintenance operations are streamlined and fast because hydraulic, pneumatic, fuel and oil lines are equipped with Aeroquip 3000 p.s.i. Self-Sealing Couplings.

Aeroquip

Aeroquip Corporation, Jackson, Michigan • Aero-Coupling Corporation, Burbank, California (*A subsidiary of Aeroquip Corporation*)
Local Representatives in Principal Cities in U. S. A. and Abroad. Aeroquip Products are fully Protected by Patents in U. S. A. and Abroad.

# Compare actual O-ring samples

## Prove by comparison tests how Parker O-rings seal better and last longer

For trouble-free leakproof sealing, you can depend on Parker O-rings. They are precision molded of superior compounds that have been developed as the result of thousands of tests.

Elongation, tensile strength, compression set ratings, resistance to oils, fuels, chemicals, and high and low temperatures, are determined with care. Then, laboratory and service tests make sure that all rated characteristics are held.

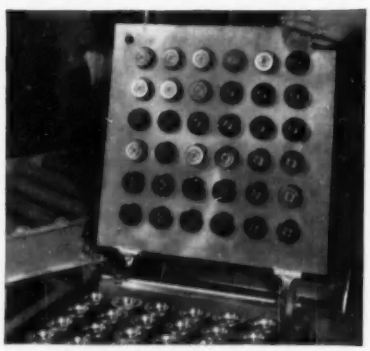
From Parker you can get exactly the *right* O-ring for your *specific* application. We invite you to compare Parker O-rings with any other make. Our engineering service will also help you with designing problems.

Send for complete engineering data today. Mail the coupon for your *free* data book or ask your Parker O-ring distributor for a copy.

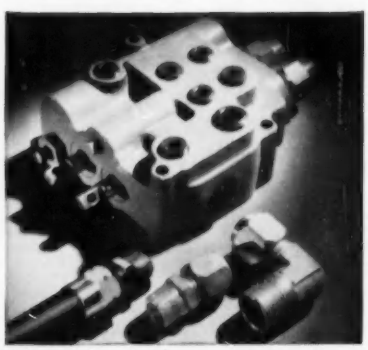
RUBBER PRODUCTS DIVISION
The Parker Appliance Company
17325 Euclid Ave., Cleveland 12, Ohio
1538 So. Eastern Ave., Los Angeles, Cal.

Parker
Hydraulic and fluid system components

**Laboratory and service tests** check compound resistance to oils, fuels and chemicals at high and low temperatures ... assuring the long life of Parker O-rings.



**Precision molding** by exclusive, automatically controlled methods assures close-tolerance fits. Parker has molds for every *standard* O-ring size. Send for data.



**What other Parker products** interest you? *Triple-lok* flare tube fittings? *Ferulok* flareless tube fittings? *Hoze-lok* fittings? New hydraulic directional control valves?

RUBBER PRODUCTS DIV.
Section 511-M
The Parker Appliance Co.
17325 Euclid Avenue
Cleveland 12, Ohio

☐ O-ring Catalog No. 5100
☐ Custom-molded Rubber Cat. No. 5201A1

Name _____ Title _____
Company _____
Address _____
City _____ State _____

# EATON Free-Valves LAST LONGER*

## Free Floating Action—

- Wipes stem and seat free of deposits
- Keeps a film of oil on stem and guide surfaces
- Prevents scuffing
- Prevents burning and guttering
- Reduces wear
- Eliminates hot spots due to local leakage

*

Performance records covering engines of all types in all kinds of service prove that Eaton Free-Valves increase valve life many times over the ordinary life expectancy of conventional valves.

Eaton Free-Valves can be applied to engines of all types and sizes, without costly design changes. Our engineers will be glad to discuss Eaton Free-Valves with you.

**EATON**

VALVE DIVISION

MANUFACTURING COMPANY

9771 FRENCH ROAD • DETROIT 13, MICHIGAN

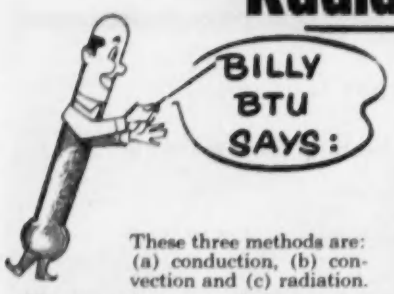
General Offices: CLEVELAND, OHIO

PRODUCTS: Sodium Cooled, Poppet, and Free Valves • Tappets • Hydraulic Valve Lifters • Valve Seat Inserts • Jet Engine Parts • Rotor Pumps • Motor Truck Axles • Permanent Mold Gray Iron Castings • Heater Defroster Units • Snap Rings Springtites • Spring Washers • Cold Drawn Steel • Stampings • Leaf and Coil Springs • Dynamatic Drives, Brakes, Dynamometers

Young Heat Transfer News

YOUNG RADIATOR COMPANY, RACINE, WIS.

# Navy Selects Young Engine Cooling Radiators for Mobile Jet Starters

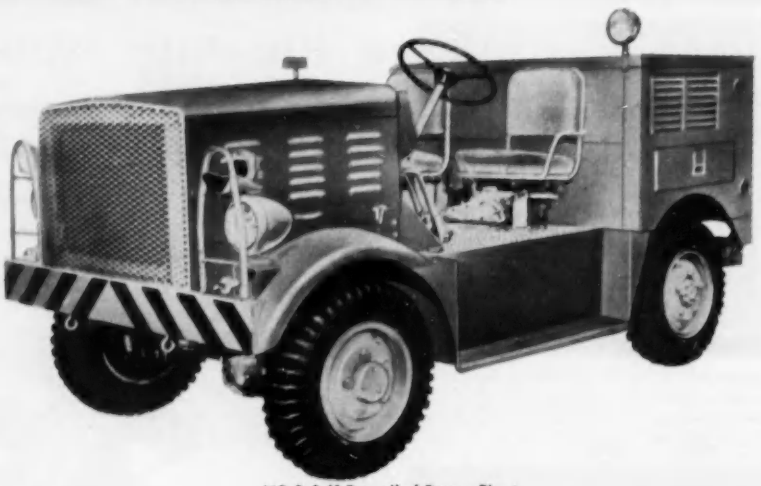



These three methods are: (a) conduction, (b) convection and (c) radiation.

Heat transfer by conduction exists when heat flows within a body from one region of high temperature to another region of lower temperature by simple molecular communication. The amount of heat which can be transferred by conduction is dependent on the temperature difference, thermal conductivity of the material through which the heat is being conducted, the distance between the hot source and the cold sink, and the cross sectional area for heat flow.

Transfer of heat by forced convection depends on the velocity of the fluids over the surface through which heat is conducted . . . by the shape of the surface, by the area through which heat is conducted . . . and by various properties of the fluid as well as temperature difference.

The third general means of heat transfer is radiation. Here heat flows from the body of the higher temperature to the body of the lower temperature through space without any medium within the space. For further details on this subject write for free bulletin: "Heat: Forced Convection Removal From Industrial Hydraulic Circuits" to Young Radiator Company, Dept. 115-D, Racine, Wis.

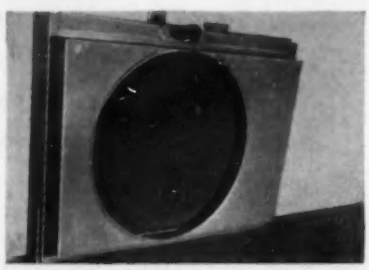


NC-5 Self-Propelled Power Plant

NC-5 Self-Propelled Power Plants are being built for the United States Navy and United States Air Force by prime contractor Consolidated Diesel Electric Corporation, Stamford, Connecticut. The vehicle is used to supply electric current for starting, towing and servicing Navy and Air Force jet planes. Its maneuverability, flexibility and speed of starting or servicing a line of planes offers many advantages over stationary or trailer types of power equipment.

Young Radiator Company fabricated Radiators for cooling the engines of these highly-specialized vehicles.

Radiator design was important because the vehicle's engine drives the 37 kw generating unit while the vehicle is at rest. The Young Radiator is constructed as an extra rugged unit with copper fin and tube core, drawn brass top and bottom tanks, and sturdy sheet metal reinforcing side members.



Rear view Young Radiator used on Navy vehicle

For further details on Young Radiators write Young Radiator Company, (Dept. 115-D) Racine, Wisconsin.

**NEW FIXED TUBE BUNDLE HEAT EXCHANGER CATALOG**

**A complete description of stock and specially engineered Young Radiator Company Type "F" Fixed Tube Bundle Heat Exchangers is given in the newly revised Catalog No. 2154. For your copy, write Dept. 115-D, Young Radiator Company, Racine, Wis.**

Young RADIATOR COMPANY

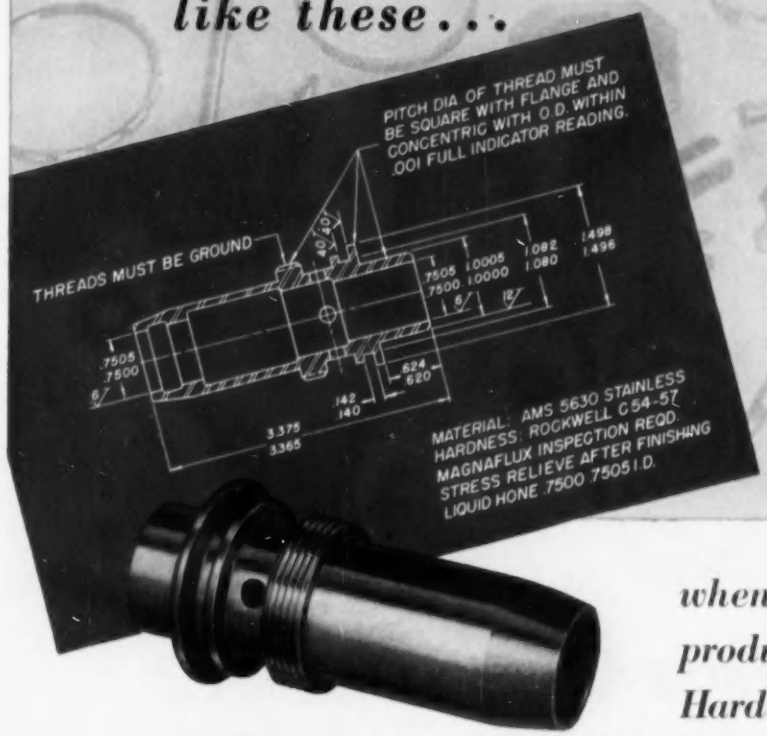
RACINE, WISCONSIN

Creative HEAT TRANSFER ENGINEERS FOR INDUSTRY

Heat Transfer Products for Automotive, Aviation and Industrial Applications. Heating, Cooling, Air Conditioning Products for Home and Industry.

Executive Office: Racine, Wisconsin, Plants at Racine, Wisconsin, Mattoon, Illinois

# *You Can Specify and Get* TOLERANCES *and* FINISHES *like these...*




## *when ALLIED'S Plant 3 produces your Precision Hardened and Ground Parts*

**Other Allied Products**

**SPECIAL COLD FORGED PARTS • STANDARD CAP SCREWS • SHEET METAL DIES PRODUCED IN IRON, ALLITE (ZINC ALLOY) AND PLASTIC • R-B INTERCHANGEABLE PUNCHES AND DIES**

An unusual example? Not at all, for it is day-in and day-out procedure at Allied's Plant 3 to produce parts held to extremely close tolerances . . . with fine surface finishes . . . meeting rigid requirements for squareness and concentricity . . . and heat treated by the most accurately controlled methods.

Regardless of how many or what type operations are called for to produce your precision parts, Allied's Plant 3 has every facility—and the proven ability—to perform these operations . . . quickly . . . economically . . . and to your *exact* specifications.

*A New 16-Page Brochure* describes and pictures in detail the facilities of Plant 3, where Allied produces precision hardened and ground parts. Included is a complete listing of all equipment in use. A copy will be sent you immediately upon request—without obligation, of course.

**ALLIED PRODUCTS CORPORATION**

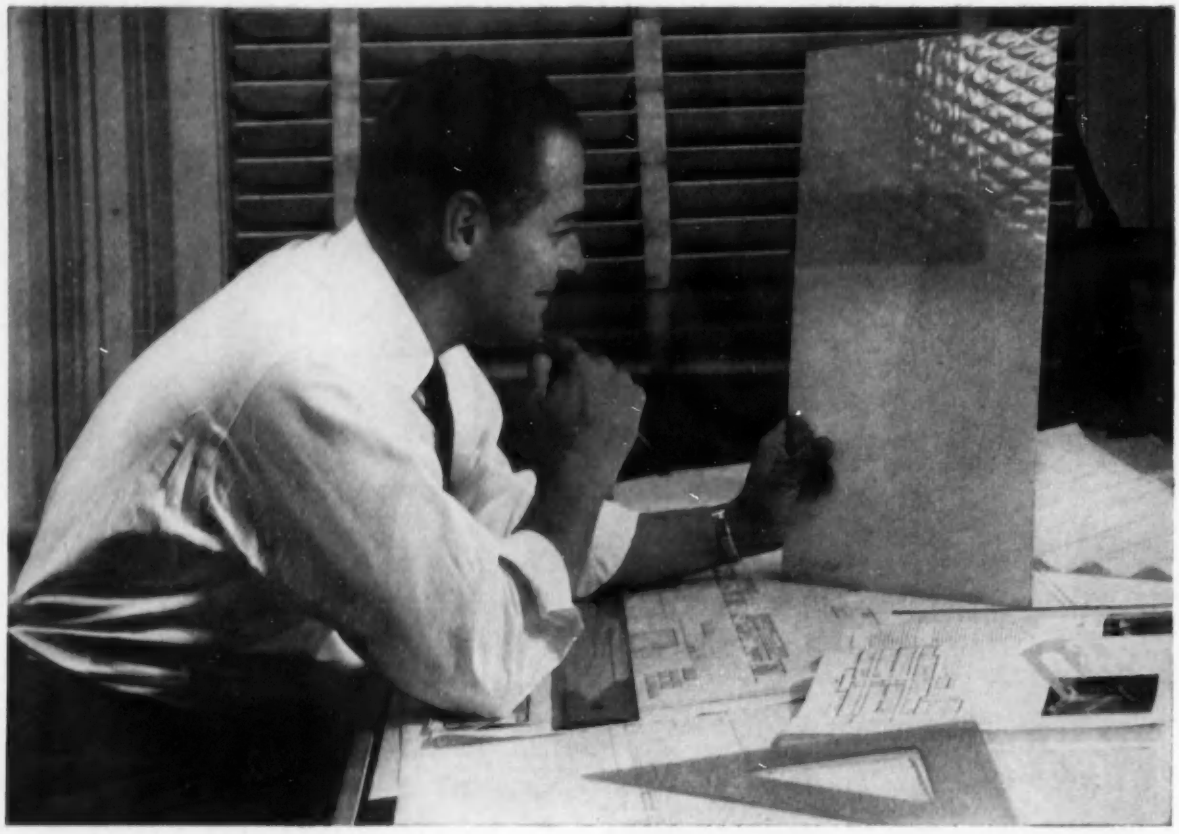
**DEPT. D-20 12643 BURT ROAD DETROIT 23, MICHIGAN**

**PLANT 1**
Detroit, Mich.

**PLANT 2**
Detroit, Mich.

**PLANT 3**
Hillsdale, Mich.

**PLANT 4**
Hillsdale, Mich.



# *Now you can get polyester laminates with* ***specific flame resistance***

If it is an application where you can use the structural strength or the style imparted by modern glass-reinforced polyester sheets . . . but need *permanent, specific fire resistance* . . . ask your fabricator or molder for laminates made with HETRON® polyester resin.

HETRON's flame resistance, which distinguishes it from virtually all other resins, is chemically locked in. The result is unique stability. There is no loss of mechanical properties, as may occur when flame resistance is obtained through the use of additives alone.

HETRON resins have the added advantages of high chemical resistance, shrinkage on cure averaging 5%, a heat distortion point of 220° F. for HETRON 92, and water absorption for the same material of 0.26% after 7 days' immersion at 73° F.

In short, HETRON resins offer you all the advantages of a good polyester material—easy moldability, machinability, and adaptability—*plus* the fact that they are self-extinguishing.

We supply the resins only, but will be glad to send you names of molders and fabricators who make HETRON-based sheets. Write also for technical data and specifications on HETRON resins.

FLAME TEST proves sheet made with HETRON polyester resin does not burn freely with exposure to blowtorch flame. Veneered wood, used as basis of comparison, ignites from candle flame and burns to destruction in five minutes.

HOOKER CHEMICALS

4-1003

*1905—Half a Century of Chemicals From the Salt of the Earth—1955*

**HOOKER ELECTROCHEMICAL COMPANY**

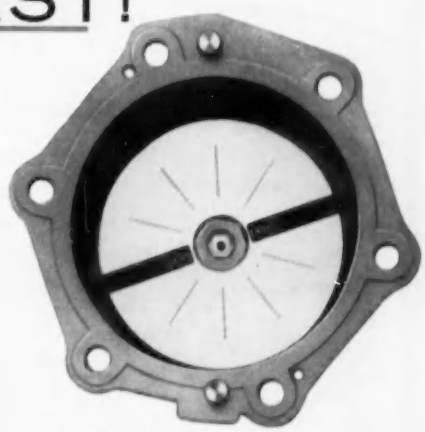
38 FORTY-SEVENTH ST., NIAGARA FALLS, N. Y.

NIAGARA FALLS • TACOMA • MONTAGUE, MICH. • NEW YORK • CHICAGO • LOS ANGELES

# Better Vision through Better Vacuum is Another AC FIRST!

The AC ROTARY VACUUM PUMP, mounted in the crankcase at the base of the oil pump, gives a boost to engine vacuum, smooths out windshield wiper action during acceleration, pumps up to 28 inches of mercury to insure plenty of power for king-size windshields — and, incidentally, improves crankcase ventilation.

Ingeniously designed, with spring-loaded vanes working off an eccentric, this AC Pump is self-lubricating, trouble-free, quiet and positive. It is typical of AC capacity to meet automotive problems. Any AC office will give your inquiry prompt and capable attention.



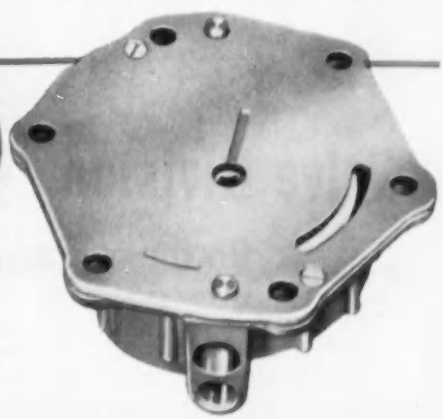
The AC Rotary Vacuum Pump, shown open (above) and with cover plate applied ready for assembly, is original equipment on all 1955 Cadillac cars.

AC QUALITY PRODUCTS

**For more than 20 years nearly every make of car has used one or more AC products**

**ADAPTERS** (Drive) • **AIR CLEANERS** • **AIR CLEANERS AND SILENCERS** (Combination) • **AMMETERS** • **BREATHERS** (Crankcase) • **CAPS** (Radiator Pressure) • **FLEXIBLE SHAFT ASSEMBLIES** • **FUEL PUMPS** • **FUEL AND VACUUM BOOSTER PUMPS** (Combination) • **FUEL FILTERS & STRAINERS** • **GASOLINE STRAINERS** • **GAUGES—AIR** (Pressure) • **GAUGES—GASOLINE** • **GAUGES—OIL** (Pressure) • **GAUGES—TEMPERATURE** (Water, Oil) • **OIL FILTERS** (Lube) • **PANELS** (Instrument) • **RECIPROCATING VACUUM PUMPS** • **ROTARY VACUUM PUMPS** • **SPARK PLUGS** • **SPEEDOMETERS** • **TACHOMETERS** • **TERMINALS** (Ignition Wire) • **VALVES** (Crankcase Ventilation)

**FLINT**
1300 North Dort Highway
**CHICAGO**
Insurance Center Building
**DETROIT**
General Motors Building



GM GENERAL MOTORS

AC SPARK PLUG DIVISION GENERAL MOTORS CORPORATION

...another Thompson "first"...

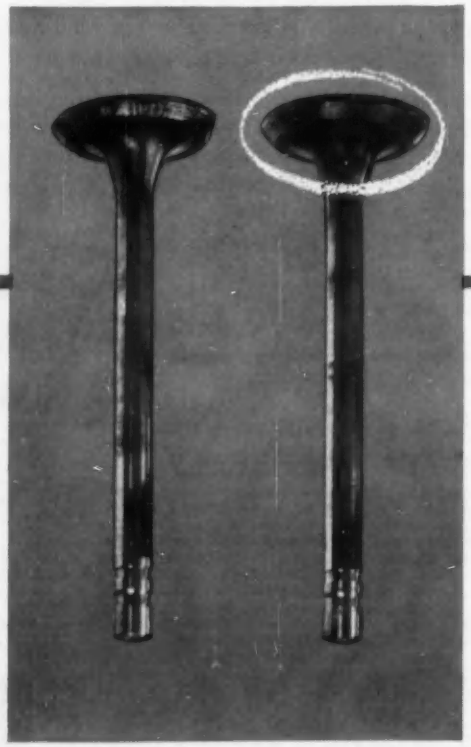
# THE VALVE DIVISION SUPPLIES ANY ENGINE BUILDER WITH ALUMINUM-COATED VALVES

...and has already produced millions of these improved longer lived aluminum-coated valves for one of the leading engine manufacturers. Thompson is the first to have the production facilities and experience to make aluminum-coated valves to meet your requirements.

Write us for details and engineering advice to adapt Thompson aluminum-coated valves to your engines for increased valve life.

*Left:* Ordinary steel exhaust valve after 80 hours of accelerated engine test.

*Right:* Thompson aluminum-coated steel exhaust valve after 300 hours under identical test conditions.



**Valve Division** of **Thompson Products, Inc.**

CLEVELAND 17, OHIO

A new light on

# OPACITY

## insures sharp reproduction from your TURQUOISE tracings

READ HOW, for the first time in pencil history, Eagle's laboratory measures the opacity of a pencil line with scientific accuracy. Three precision instruments are involved:

**(1) Our two-ton "Pencil Sharpener" gives the test pencil a cylindrical point (as shown at left) of fixed diameter, accurate to .0001".**

**(2) In our Automatic Shading Machine, the pencil deposits graphite as a square of parallel strokes under uniform pressure on the paper.**

**(3) A Microammeter, connected to a sensitive light cell, first measures the light blocked by the chart paper, and then measures the opacity of the graphite deposit alone to a fraction of one percent!**

Such exact measurement of every TURQUOISE degree enables us to develop and maintain maximum opacity . . . the quality that gives you perfect prints from TURQUOISE pencil tracings.

PROVE IT IN THE PRINT with a free TURQUOISE sample.
Just write us, naming this magazine and the grade you prefer.

EAGLE

*"Chemi-Sealed" (Super Bonded)
*TURQUOISE *Drawing Pencils & Leads*
With 100% *"Electronic" Graphite

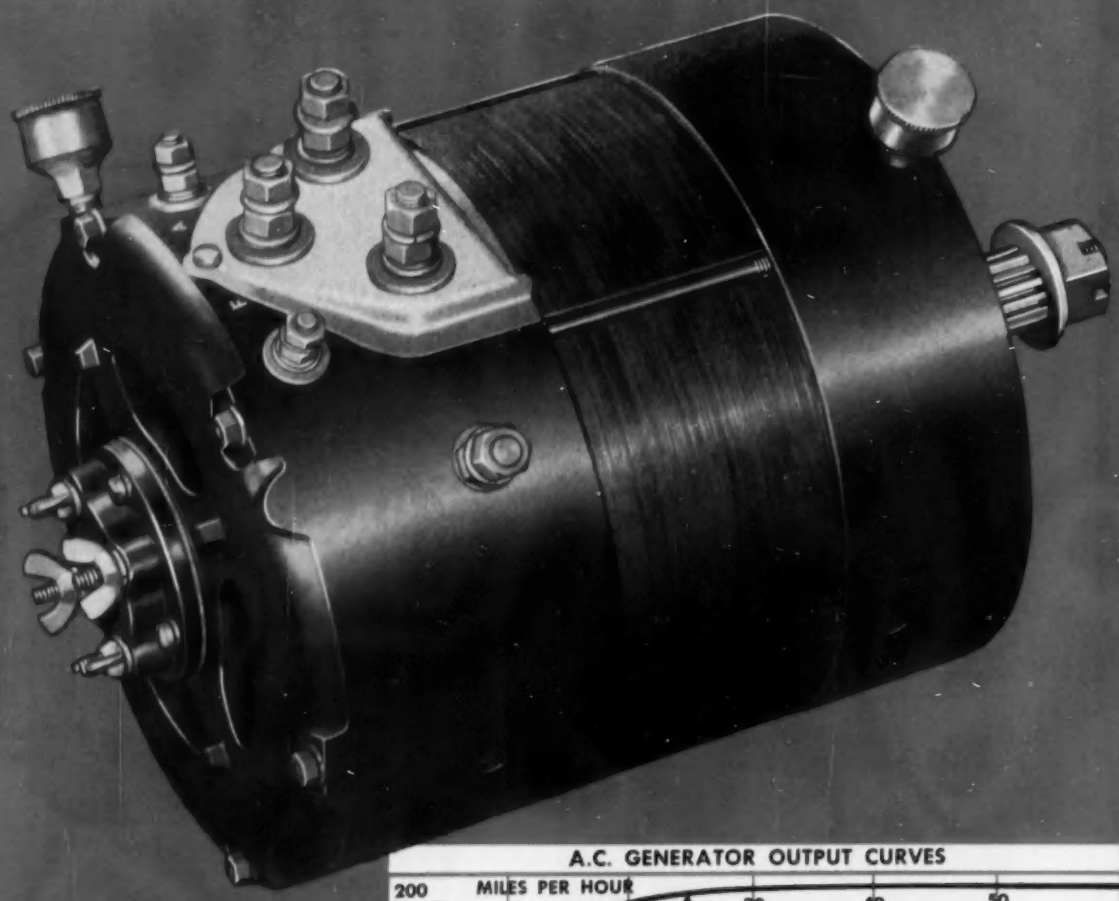
EAGLE PENCIL COMPANY • NEW YORK • LONDON • TORONTO • MEXICO • SYDNEY

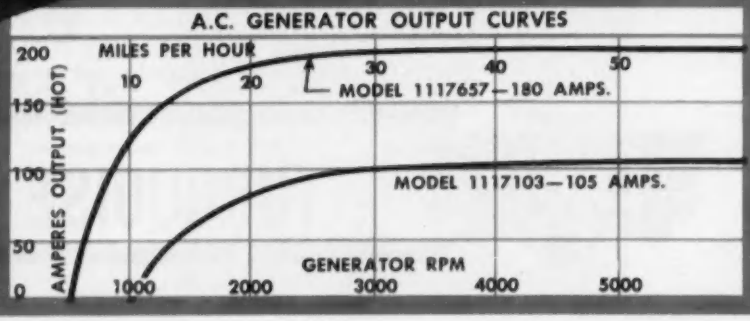
# Progressive Engineering

**A.C. GENERATOR PERFORMANCE DATA**

| Model | Volts | Cut-In RPM* | Curb Idle Amperes* | Maximum Amperes | Power Watts | Recommended For |
|---|---|---|---|---|---|---|
| 1117103 | 12 | 975 | 6 | 105 | 1260 | All speeds. |
| 1117657 | 12 | 625 | 100 | 180 | 2160 | All speeds. |
| 1117062-3-4 | 6 | 750 | 30-40 | 90 | 540 | All speeds. |

*APPROXIMATE (BASED ON 100 GENERATOR RPM/MPH)





# Makes the Difference

**DELCO-REMY'S NEW THUNDERVOLT A.C. GENERATORS ANSWER THE WIDE VARIETY OF NEEDS IN HEAVY-DUTY APPLICATIONS**

The electric power demands of modern buses, fire trucks and similar vehicles are heavy, continuous, and varied —ranging from alternating current for fluorescent lighting to direct current for other electrical equipment. The supply problem is further complicated by long and frequent periods of engine idling. But here's the answer to these problems—Delco-Remy's ThunderVolt-6 and -12 A.C. generators, designed specifically for vehicles with extra-heavy electrical loads.

The features of these new generators are many and impressive. Performance-wise, their characteristics include cut-in at low generator rpm, maximum output at low speeds, and the ability to operate at maximum efficiency over a wide speed range. Structurally, they are extremely low in weight in proportion to their tremendous output.

These new special-purpose generators are another example of Delco-Remy leadership in the automotive electrical field. Specify Delco-Remy electrical equipment for your new heavy-duty vehicles.

COPYRIGHT 1955—DELCO-REMY DIVISION, GENERAL MOTORS CORPORATION

Delco-Remy
ThunderVolt
ELECTRICAL SYSTEMS

DELCO-REMY • DIVISION OF GENERAL MOTORS • ANDERSON, INDIANA

ANOTHER "U. S." ENGINEERED RUBBER PRODUCT
SERVING THE AUTOMOTIVE INDUSTRY

# Look to "U. S." for your ADHESIVE needs

## Consider these advantages:

1. United States Rubber Company is a specialist in rubber adhesives. "U. S." provides specialized engineering service to the automotive industry.
2. "U. S." is equipped to make vast quantities of adhesives, both solvent and water-dispersion types.
3. "U. S." makes its adhesives from natural rubber, reclaim rubber, GR-S, Neoprene, and Buna-N, to provide standard or specially-compounded adhesives to handle any bonding problem encountered by the automotive industry.
4. Shipments are made quickly and at *low* freight cost from central locations.

**For fast, immediate service or placement of orders, phone Trinity 4-3500 or contact the address below.**

*"U. S." Research perfects it..."U. S." Production builds it.*

**UNITED STATES RUBBER COMPANY**

**Automotive Sales, Mechanical Goods Division, New Center Building, Detroit 2, Michigan**

# Why CHOOSE MENASCO?

*. . . Because* **MENASCO**

**LEADS THE DESIGN TREND**

*First in* DEVELOPMENT, QUALITY, DELIVERY & SERVICE

At Menasco all departments—research, development and production—work as a team to meet the challenge of stronger, lighter, more efficient and compact aircraft landing gear. That is why Menasco has consistently led the design trend. Typical of Menasco engineering achievements is this nose gear for the Convair F-102. Menasco's proposal provided Convair a saving of 15% in critical landing gear weight. This interesting design, now in service, combines the most effective application of both steel and aluminum. Menasco's advanced engineering approach to the weight question can also be applied to your landing gear problems.

*Specialists in Aircraft Landing Gear*

**menasco manufacturing company**

805 SOUTH SAN FERNANDO BOULEVARD, BURBANK, CALIFORNIA

## THE WHOLE ROHR STORY
# IS IN MILLIONS OF PARTS!

ROHR has won fame for becoming the world's largest producer of ready-to-install power packages for airplanes . . . like the Lockheed Constellation, Douglas DC-7, the all-jet Boeing B-52 and other great military and commercial planes. But there's far more to the ROHR story!

In addition to power packages, ROHR aircraftsmen are currently producing over 30,000 other different parts for aircraft of all kinds.

Whenever you want aircraft parts better, faster, cheaper... call on ROHR. Remember, the whole ROHR story is in the great engineering skill and production know-how gained from building thousands upon thousands of power packages and millions of other aircraft parts.

WORLD'S LARGEST PRODUCER

OF READY-TO-INSTALL POWER PACKAGES FOR AIRPLANES
*–RECIPROCATING, TURBO-PROP, TURBO-COMPOUND AND JET.*

**ROHR**
AIRCRAFT CORPORATION

CHULA VISTA AND RIVERSIDE CALIFORNIA

*Under the hood of the stunning new Chrysler...*

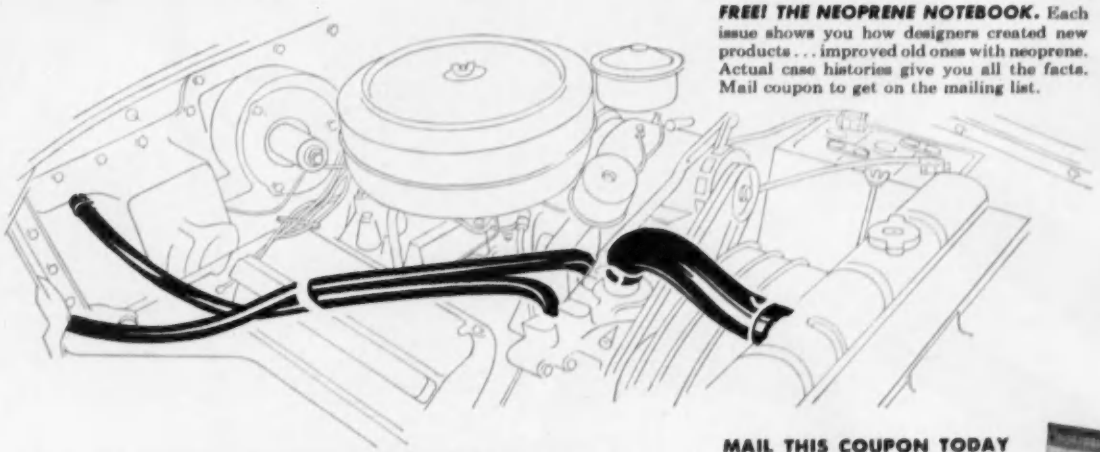
# Neoprene radiator and heater hose dependably performs... resists oil, heat and chemical attack

Every part of the 1955 Chrysler is designed for long, dependable service—right down to radiator and heater hose made with neoprene tube and cover.

On these hoses, the neoprene covers resist softening by engine heat—deterioration from grease, oil and even accidental splashes of battery acid. And the neoprene tubes stay smooth and firm despite contact with anti-freeze and rust inhibitors.

Neoprene, Du Pont's chemical rubber, is well suited for automotive use. Because it stands up where ordinary resilient materials fail, neoprene is first choice among designers for key parts that improve performance . . . rarely need replacement.

***FREE! THE NEOPRENE NOTEBOOK.*** Each issue shows you how designers created new products . . . improved old ones with neoprene. Actual case histories give you all the facts. Mail coupon to get on the mailing list.



**NEOPRENE**

***The rubber made by Du Pont since 1932***

DU PONT

REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

**MAIL THIS COUPON TODAY**

E. I. du Pont de Nemours & Co. (Inc.)
Elastomers Div., Dept. SA-4
Wilmington 98, Delaware

Please put my name on the mailing list for the Neoprene Notebook.

*Name*_____ *Position*_____

*Firm*_____

*Address*_____

*City*_____ *State*_____

# HOW R/M ENGINEERING SETS

R/M
FIRST IN FRICTION

These are just a few of the friction parts—brake linings, clutch facings and automatic transmission bands—that R/M makes of woven asbestos.

***THE RECORD OF "FIRSTS" IN FRICTION MATERIAL DEVELOPMENT SHOWS WHY R/M IS FIRST IN FRICTION***

**FIRST Woven Brake Lining • FIRST Asbestos Brake Lining • FIRST Ground Wearing Surface • FIRST Zinc Alloy Wire Brake Lining • FIRST Pre-Treated Yarns • FIRST Extruded Pulp Brake Lining • FIRST Flexible Pulp Brake Lining in Rolls • FIRST Dry Process Brake Lining • FIRST Semi-Metallic Brake Lining • FIRST Bonded-to-Metal Brake Lining • FIRST Woven Clutch Facings • FIRST Molded Asbestos Clutch Facings for Clutches Operating in Oil FIRST Endless Woven Clutch Facings • FIRST Pre-Treated Clutch Facings • FIRST Bonded-to-Metal Clutch Facings**

# THE PACE IN FRICTION MATERIAL DEVELOPMENT

## WOVEN BRAKE LININGS AND CLUTCH FACINGS

In either wet or dry operation, R/M Woven Asbestos Friction Materials offer specialized performance characteristics that could help solve problems you may be facing now.

No other material, for example, gives the same "feel" in automatic transmissions—or in passenger car brakes. No other material is as good for band brakes in oil well equipment. And R/M Woven Asbestos is now being used in applications as divergent as baby carriage brakes and fishing reel drags.

Raybestos-Manhattan, for over 50 years the world's largest maker of friction materials, has pioneered in the development of woven asbestos. R/M made the first woven brake lining—the first woven clutch facings. And continuous research and testing has given R/M a fund of knowledge concerning woven asbestos friction materials second to none in the industry.

By changing the mix ratio of asbestos and cotton, by using different yarn sizes and twists, and by variation of pretreatment and final treatment, R/M can produce in woven asbestos a range of friction characteristics that may well meet your requirements better than any other material.

In many applications, however, you will get best results by combining woven asbestos with other friction materials. Such combinations tend to keep the friction level more normal, since the different materials do not reach their critical points at the same time. And due to making all kinds of friction materials, R/M is in an ideal position to develop just the right combination for your needs.

**R/M Works with All Kinds of Friction Materials**

R/M offers the widest range of friction materials in the industry . . . from woven and molded asbestos to cork-cellulose, sintered metals, and ceramics. This is of major importance to the O.E.M. For it means that by consulting R/M, he can get the benefits of wider experience, and he can be sure of absolutely unbiased advice on which materials or combinations of materials are best suited to his individual application.

If you feel that friction material performance could be improved in any equipment you manufacture, contact Raybestos-Manhattan now. All the depth and breadth of R/M experience is as near as your telephone.

*Write for your free copy of R/M Bulletin No. 500. Its 44 pages are loaded with practical design and engineering data on all R/M friction materials.*

R/M
FIRST IN FRICTION

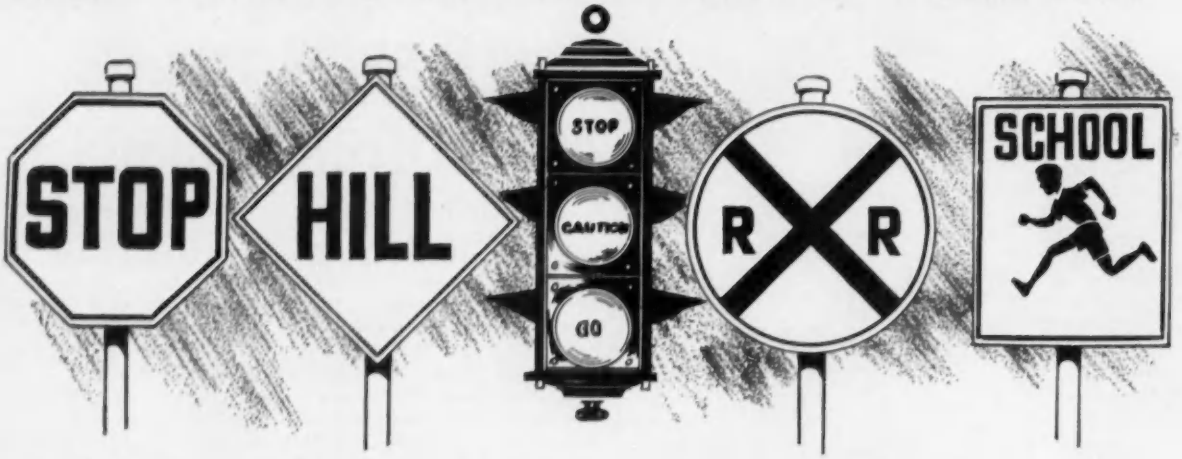
THE TRADE-MARK THAT SPELLS PROGRESS IN FRICTION MATERIAL DEVELOPMENT

# RAYBESTOS-MANHATTAN, INC.

**EQUIPMENT SALES DIVISION: 6010 Northwest Highway, Chicago 31, Ill. · Detroit 2 · Cleveland 14 · Los Angeles 58**
FACTORIES: Bridgeport, Conn. Manheim, Pa. Passaic, N.J. No. Charleston, S.C. Crawfordsville, Ind. Neenah, Wis.
Canadian Raybestos Co. Ltd., Peterborough, Ontario, Canada

RAYBESTOS-MANHATTAN, INC., Brake Linings • Brake Blocks • Clutch Facings • Fan Belts • Radiator Hose • Industrial Rubber, Engineered Plastic, & Sintered Metal Products • Rubber Covered Equipment • Asbestos Textiles • Packings • Abrasive & Diamond Wheels • Bowling Balls

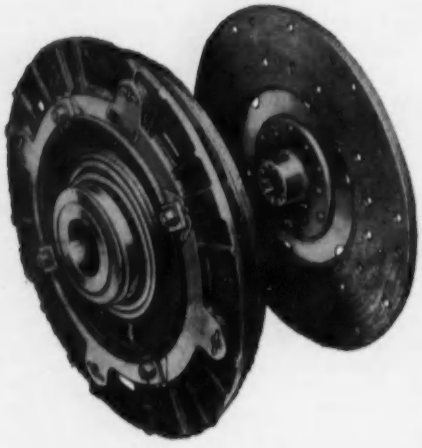
# SHIFT...SHIFT...and SHIFT AGAIN!




# *Lipe* clutches can take it!

A traffic sign or signal light may mean another —and another—clutch engagement . . . yet the Lipe ML Clutch engages so smoothly there's no grab, shock or jerk.

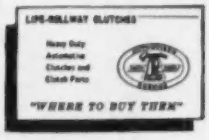
Perfect engagement like this means less stress on the engine, drive line, axle and rubber—less maintenance—more mileage between tear-downs.



## Why LIPE Clutches Last Longer . . .

There's only one spring. This acts on 20 levers which press instantly and uniformly on the pressure plate. Friction surfaces are brought together with absolute parallelism. No cocking of the plate—no high spots, no localized burning. Simple shim adjustment maintains this precise engagement over long-time operation.

Write for free Lipe Clutch Service Manual. For quick service on genuine Lipe parts, look for this ad in the yellow pages of the telephone directory in principal cities.



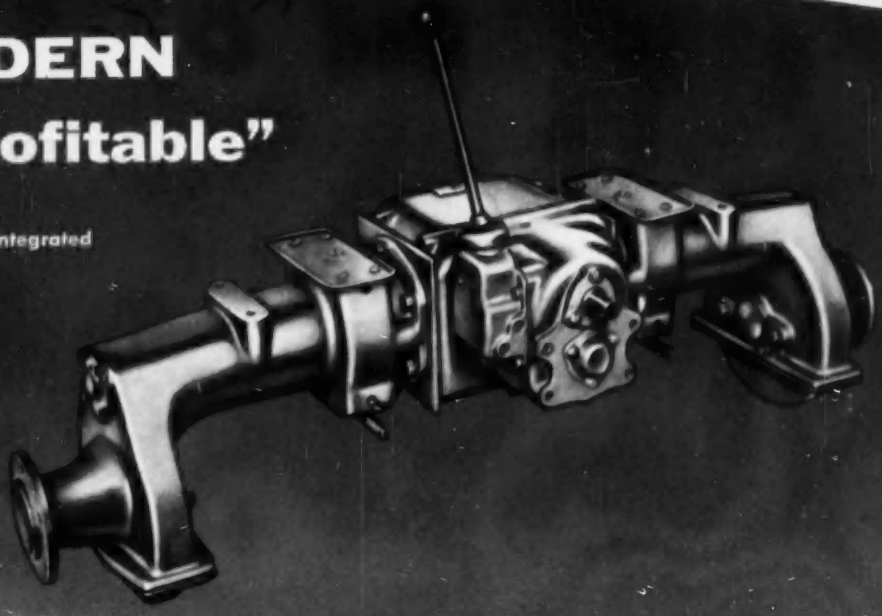

LIPE ROLLWAY

*Lipe* – ROLLWAY CORPORATION

Manufacturers of Automotive Clutches and Machine Tools

Syracuse 1, N. Y.

# When MODERN means "Profitable"



Here's good functional design: an integrated transmission-axle driving unit developed especially for a farm tractor, through Clark engineering collaboration. . . . This design trend is wholesomely modern; and the number of leading manufacturers employing this design—agricultural and industrial, highway and off-highway—is positive proof that it's also exceedingly profitable.

**CLARK® EQUIPMENT**

CLARK EQUIPMENT COMPANY • BUCHANAN • Battle Creek, Jackson and Benton Harbor, Michigan

## Clark puts the driver where he belongs

# . . . on the new
# ELECTRIC TOWING TRACTOR

Clark's new electric towing tractor, rated up to 3000 lbs. breakaway drawbar pull, is the first *true* tractor-type electric machine on the market. The driver sits where he belongs—at the rear of the tractor, within arm's reach of the coupler. He does not have to get off the tractor to couple onto a load. He does not have to jockey around to get in position to hook-up, because he can see the coupler from his seat. This means time savings and energy savings (for both driver and batteries).

Another advantage of this basic design is the well balanced distribution of battery weight for both maximum driving and steering traction. Regardless of steep ramps or heavy pulls, there is no "bucking" with the maximum battery weight positioned within the wheelbase. And like Clark electric lift trucks, the new tractor is designed to work a longer cycle without recharging batteries—the maximum in battery efficiency.

- Easy on-and-off access
- Finger-tip direction control
- Rigid box-type frame: Heavy integral welded plates provide strength for bumping, pushing or pulling.
- Four speeds forward and reverse
- Four coupler types available
- Straight series wound motor: develops comparatively large increases in torque with only moderate increase in current draw; 36 to 48 volts; sealed-for-life bearings.
- Parts interchangeability: Many components are common to the Clark line of electric lift trucks.

CLARK EQUIPMENT

Industrial Truck Division, CLARK EQUIPMENT COMPANY, Battle Creek, Michigan

# More than a full measure of performance

## ...thanks to BORG-WARNER Engineering

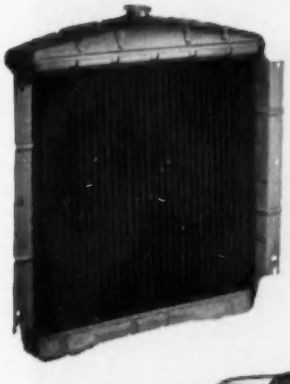
Brimming with power, today's high-horse engines impose tremendous demands on other automotive components.

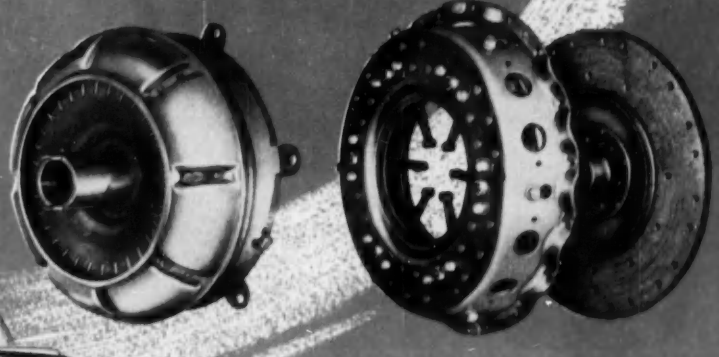
Torque converters and clutches must be engineered more efficiently to withstand rapid acceleration, sustained high speeds and punishing stops. Radiators must dissipate more heat faster, yet stay slim and sleek as the cars they cool.

Knowing this, engineers at Borg-Warner's Long Manufacturing Division insist on exceeding their own consistently high standards. Performance has to be better than good . . . a philosophy in force over 50 years.

That's why Long components . . . engineered for *more* than a full measure of performance . . . are in use on millions of cars, trucks, tractors, buses, boats and stationary engines. They're really rugged and dependable . . . typical of the 185 performance-proved Borg-Warner products that serve the American public every day.

LONG





B-W engineering makes it work
B-W production makes it available

ENGINEER B-W PRODUCTION

# BORG-WARNER

THESE UNITS FORM BORG-WARNER, *Executive Offices, Chicago*: ATKINS SAW • BORG & BECK • BORG-WARNER INTERNATIONAL • BORG-WARNER, LTD. • BORG-WARNER SERVICE PARTS • CALUMET STEEL • DETROIT GEAR • FRANKLIN STEEL • HYDRALINE PRODUCTS • INGERSOLL CONDITIONED AIR • INGERSOLL KALAMAZOO • INGERSOLL PRODUCTS • INGERSOLL STEEL • LONG MANUFACTURING • LONG MANUFACTURING CO., LTD. • MARBON CHEMICAL • MARVEL-SCHEBLER PRODUCTS • MECHANICS UNIVERSAL JOINT • MORSE CHAIN • MORSE CHAIN OF CANADA, LTD. NORGE • PESCO PRODUCTS • REFLECTAL CORP. • ROCKFORD CLUTCH • SPRING DIVISION • WARNER AUTOMOTIVE PARTS • WARNER GEAR WARNER GEAR CO., LTD. • WAUSAU • WESTON HYDRAULICS, LTD. • WOOSTER DIVISION

*The man who needs a new machine tool and doesn't buy it is paying for it anyway...*

**in hidden tooling costs**

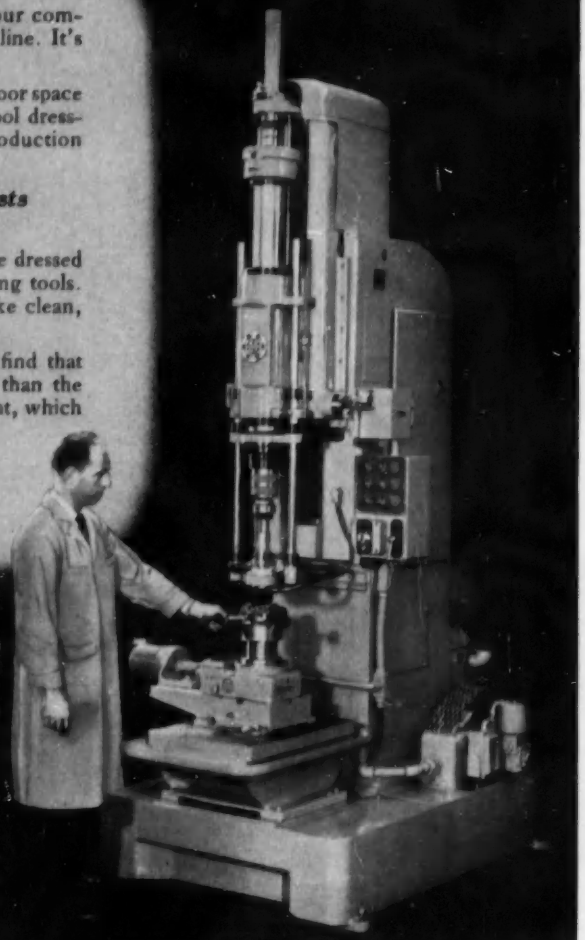
THE difference between your costs and your competitors' may be hidden behind the production line. It's the cost of maintaining your tooling.

There's time lost for tool sharpening! Extra floor space for extra machines in the tool room! Skilled tool dressers! Chuck alignment and maintenance! Production lost for wheel dressing!

***One answer to hidden tooling costs is Microhoning***

Instead of bits to be sharpened and wheels to be dressed Microhoning uses self-aligning, self-dressing tools. Throughout their life Microhone abrasives make clean, uniform cuts.

Look behind the production line and you'll find that your hidden tooling expense may total more than the cost of the latest type of Microhoning equipment, which would assure you of increased output, uniform quality, consistent accuracy of dimension and a functional surface finish. In short, you are paying right now for the new machine tools you don't have.



*Surface:* Spline in gear
*Condition:* Distorted by heat-treating

**PROBLEM:**

Excessive tooling cost—frequent changing and sharpening of tools—annealing of surface required—poor surface finish.

**SOLUTION:**

MICROHONING—Tool self sharpening—annealing not necessary—clean, consistent surface finish generated.

**MICROMATIC HONE CORPORATION**

**8100 SCHOOLCRAFT AVE., DETROIT 38, MICHIGAN**

MICROMATIC HONE CORP.
2205 Lee Street
Evanston, Illinois

MICROMATIC HONE CORP.
1535 Granda Vista Avenue
Los Angeles 23, California

MICROMATIC HONE LTD.
330 Grand River Avenue
Brantford, Ontario, Canada

MICROMATIC HONE CORP.
MICRO-MOLD MFG. DIV.
Boston Post Road
Guilford, Connecticut

MICROMATIC HONE CORP.
MICRO-MOLD MFG. DIV.
231 So. Pendleton Avenue
Pendleton, Indiana

REPRESENTATIVES: Allied Northwest Machine Tool Corp., 103 S.W. Front Ave., Portland 4, Oregon · Mason Machine Tool Company, 415 So. Second East, Salt Lake City, Utah · Perine Machinery & Supply Co., 1921 First Ave. South, Seattle 4, Washington

REPRESENTATIVES IN ALL PRINCIPAL COUNTRIES

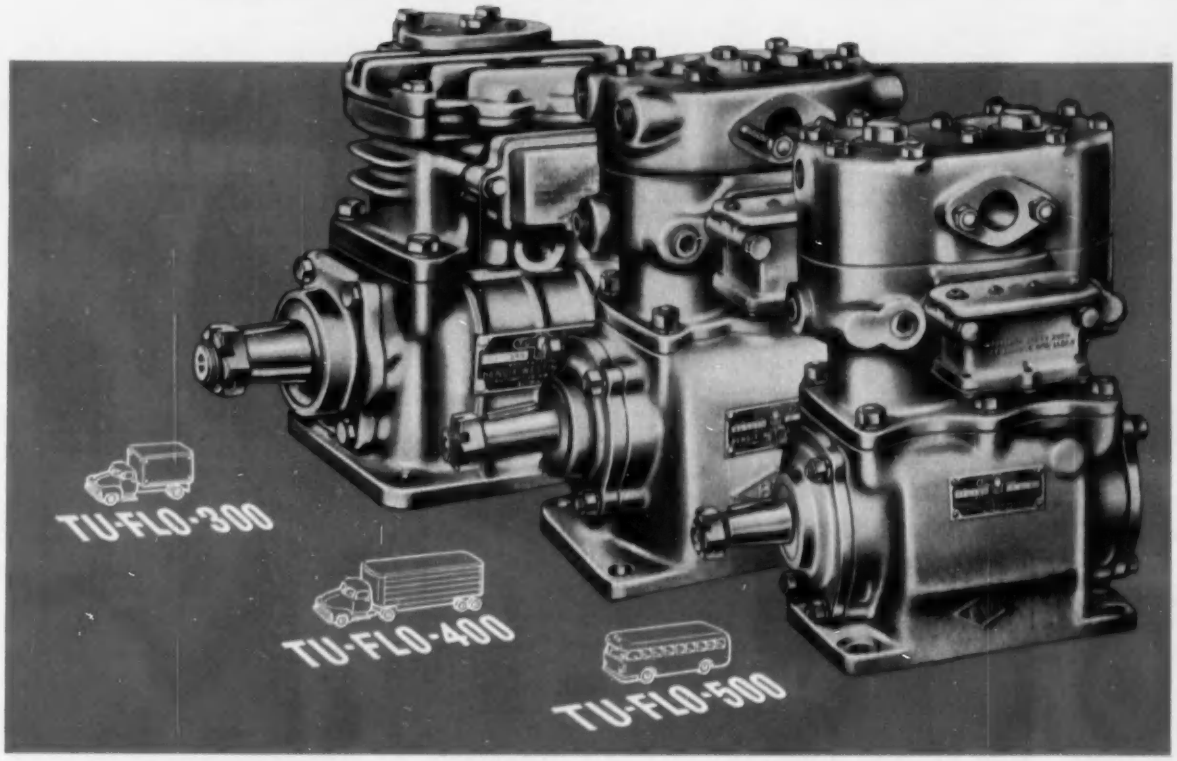
**MICRO-PRECISION DIVISION**
**2205 Lee Street, Evanston, Illinois**

Hydraulic controls
Diesel fuel injection equipment

NOW—Air Brakes for EVERY SIZE Vehicle!

# Bendix-Westinghouse

## TU-FLO SERIES




**A COMPLETE LINE OF SUPERIOR COMPRESSORS BRINGING THE HIGHEST EFFICIENCY AND BEST PERFORMANCE EVER OFFERED TO THE TRUCK AND BUS INDUSTRY!**

Here is an outstanding line of brand-new compressors for 1955—covering the entire range of trucks, tractors, buses and off-the-road equipment—from the smallest to the largest—with maximum braking performance assured every vehicle.

Road-tested for millions of miles—laboratory-tested for thousands of hours—job-tested and efficiency-rated from design boards to production final test—these are the finest compressors ever built for the automotive industry.

- Lower discharge temperatures over the entire speed range.
- Increased air delivery at low and intermediate speeds, where most required.
- Capable of operating at higher maximum speeds to match trends in engine design.
- Improved oil control.
- New-design inlet valves.
- New unloading mechanism.
- No external moving parts—no need for periodic adjustments.
- Available with attached governor, if desired.
- All compressors available either self-lubricated or engine-lubricated.
- Tu-Flo 300—air cooled.
  Tu-Flo 400—air or water cooled.
  Tu-Flo 500—water cooled.

Bendix-Westinghouse

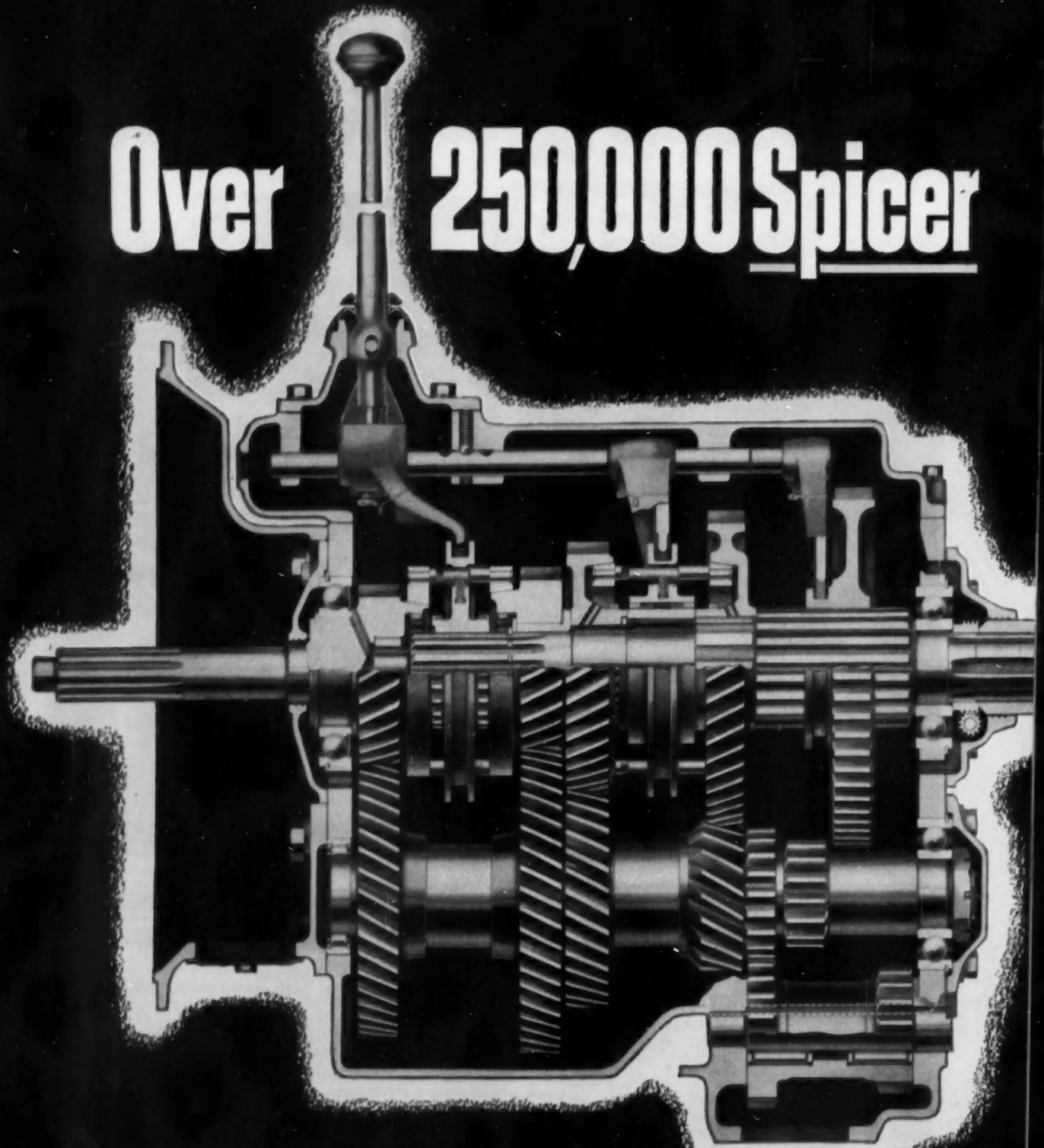
*The World's Most Tried and Trusted Air Brakes*

BENDIX-WESTINGHOUSE AUTOMOTIVE AIR BRAKE COMPANY

General Offices and Factory—Elyria, Ohio • Branches—Berkeley, Calif., Oklahoma City, Okla.

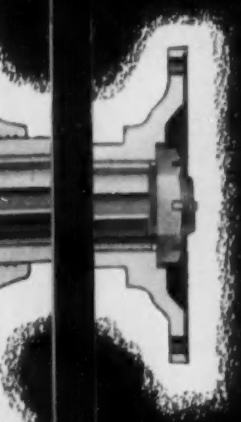
BENDIX-WESTINGHOUSE AIR BRAKES REG. U.S. PAT. OFF.

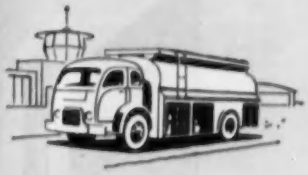
# Over 250,000 Spicer

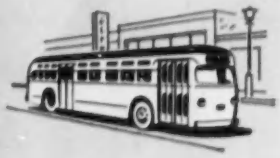


## DANA CORPORATION

# Fully-Synchronized TRANSMISSIONS







## have been built since 1934 for every kind of heavy-duty civilian and military use!

**SPICER PRODUCTS:** TRANSMISSIONS • UNIVERSAL JOINTS • PROPELLER SHAFTS • AXLES • TORQUE CONVERTERS • GEAR BOXES • POWER TAKE-OFFS • POWER TAKE-OFF JOINTS • RAIL CAR DRIVES • RAILWAY GENERATOR DRIVES • STAMPINGS • SPICER and AUBURN CLUTCHES • PARISH FRAMES

**TOLEDO 1, OHIO**

Spicer

**KEUFFEL & ESSER CO.**

EST. 1867

**New York • Hoboken, N. J.**

Chicago • St. Louis • Detroit
San Francisco • Los Angeles • Montreal
Distributors in Principal Cities

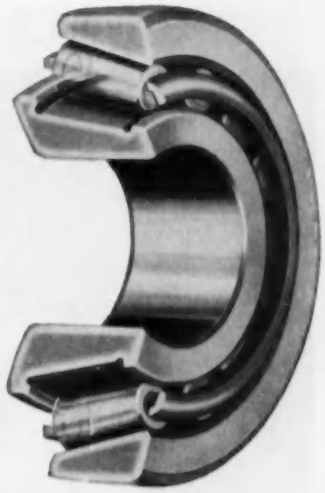
• **Since 1867 engineers, scientists, designers, surveyors, draftsmen have relied on K&E as the foremost, most progressive, and most complete source of supply for the tools, equipment, and materials they work with. When you buy, think first of K&E, headquarters for 7,000 items. For example . . .**

## GRAPH SHEETS

To fill the needs of engineers, draftsmen, surveyors, mathematicians, statisticians and scientists, as well as business men, manufacturers, architects and others, exactly, K&E makes a complete range of graph sheets, cross section and profile papers and cloths. These are fully described and illustrated in the 64-page booklet, "K&E Graph Sheets" which also contains a helpful guide to their selection and use. For a free copy, write Keuffel & Esser, Dept. 255, Hoboken, N.J.

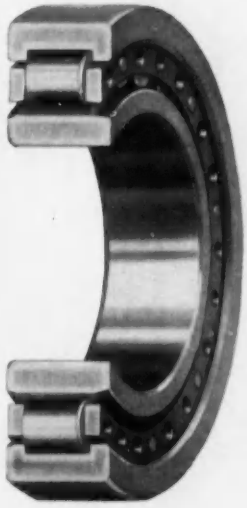
**WHATEVER YOUR ROLLER BEARING APPLICATION**

# specify BOWER!



Earthmovers, jet turbine engines, rolling mill equipment, truck axles—you name it! Bower builds a complete line of tapered, straight and journal roller bearings including a size and type to fit *your* product. What's more, these dependable bearings have *proved* themselves in virtually every conceivable type of application. Their built-in quality, skillful engineering and advanced design features provide such important bearing advantages as reduced wear, longer life and lower maintenance requirements. Let a Bower engineer give you full details on the complete Bower line.

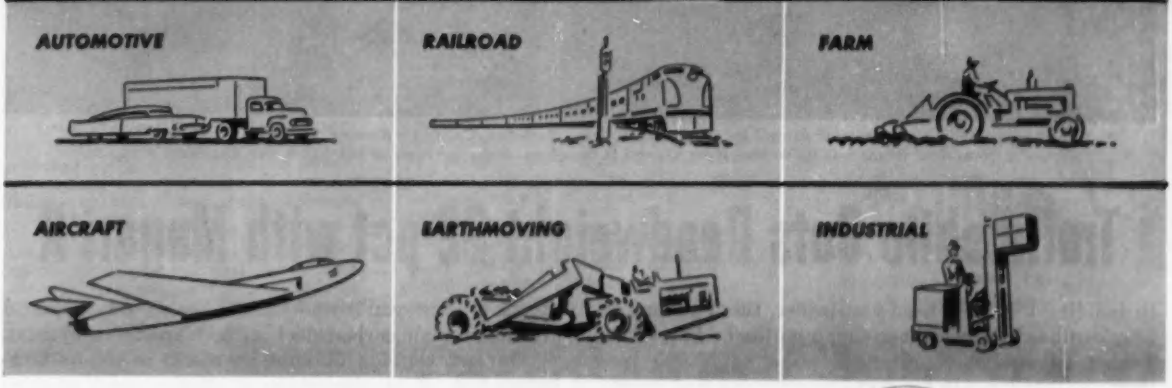
BOWER ROLLER BEARING COMPANY
DETROIT 14, MICHIGAN



***BOWER TAPERED ROLLER BEARINGS INCORPORATE ADVANCED SPHER-O-HONED DESIGN!*** Spherically generated roll heads and higher flange with larger, two-zone contact area reduce wear, improve roller alignment and virtually eliminate "end play." This helps hold adjustment and pre-load longer and better. Larger oil groove provides positive lubrication.

***BOWER STRAIGHT ROLLER BEARINGS ARE BUILT TO CARRY MAXIMUM LOADS!*** Integral two-lip race increases rigidity—keeps rollers in proper alignment at all times. Steel cage allows free movement of rollers between races during normal operation. High-grade alloy-steel rollers and races are precision-ground for quieter, smoother operation.

**A COMPLETE LINE OF TAPERED, STRAIGHT AND JOURNAL ROLLER BEARINGS**
*for every field of transportation and industry*




BOWER
ROLLER BEARINGS

SPHER-O-HONED

**Mayari R** makes it lighter... stronger... longer lasting

In this spacious trailer manufactured by Trailmobile, Inc., Berkeley, Calif., fir flooring is screwed to Mayari R floor supports. Rear door frame was jig-welded from Mayari R members. Note lightness of Mayari R vertical panel supports.

# Trailmobile Cuts Deadweight 32 pct with Mayari R

In building this 24-ft semi-van trailer, the Trailmobile people utilized the weight-saving qualities of Mayari R. Taking advantage of its yield point of 50,000 psi, they used Mayari R for such members as roof bows, floor bolsters, rear suspension framing, superstructure and landing gear frame brackets. Result: a *stronger* trailer with 32 pct less deadweight.

What Trailmobile is doing with Mayari R may well be feasible in your plant too. Besides its superior mechanical properties, you can take advantage of its excellent resistance to atmospheric corrosion, impact, batter, vibration. And you'll find that it welds and forms as readily as plain carbon steel, without special equipment.

Our new Catalog 353 contains plenty of helpful technical data, along with dozens of illustrations that point up the versatility of Mayari R. To get a copy promptly, just call or write the Bethlehem office nearest you.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

*On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation*

BETHLEHEM STEEL

# Automotive engineers see solution to *low-duty* engine sludge problems

**Two new polymeric additives, Du Pont Lube Oil Additives 564 and 565, provide efficient low-duty detergency and V.I. improvement**

For several years, there have been effective lube oil detergents for heavy-duty operation . . . but no additive that would economically overcome low-duty sludge problems.

Yet, for 48% of American passenger cars, the average trip is less than 4 miles. For 75%, it is less than 10 miles. And for all city buses, taxis and delivery trucks, more than 90% of their total operation is in local stop-and-go traffic. These low-power, low-temperature operating conditions lead to excessive build-up of engine sludge.

**Double Action**

After many years of research on this problem, Du Pont has developed two entirely new-type synthetic detergents . . . Lube Oil Additives 564 and 565. Both are *polymeric* additives that provide an economical and effective means of preventing engine oil sludge . . . particularly under low-duty, stop-and-go driving conditions. And both do double duty as detergents and V. I. improvers.

**Du Pont Lube Oil Additive 564** has a relatively *low molecular weight*. It provides motor oils with *good shear stability* as well as viscosity index improvement, coupled with outstanding detergency.

**Du Pont Lube Oil Additive 565** has a relatively *high molecular weight* and provides greater *viscosity index improvement*, along with equally outstanding detergency under low-duty driving conditions. These characteristics enable refiners to make multi-graded oils of superior quality at lower cost.

**More efficient operation**

These new ashless polymeric additives permit more efficient operation of the engine oil system. Oil screens, rings, pistons, filters and other engine parts are kept clean and free from sludge. The resulting free flow of oil throughout the entire engine keeps it in better operating condition for longer periods.

Developing new additives for improved fuel and lubricant performance is a continuing project of the Du Pont Petroleum Laboratory. And these two new lube oil additives are among the latest results of this project. For more complete details, ask for a copy of "Du Pont Lube Oil Additives 564 and 565." Address your request to any of our regional offices listed below.

DU PONT

Better Things for Better Living
. . . through Chemistry

# Petroleum Chemicals

**E. I. DU PONT DE NEMOURS & COMPANY (INC.)**
*Petroleum Chemicals Division • Wilmington 98, Delaware*

*Regional Offices:*
NEW YORK, N. Y.—1270 Ave. of the Americas . . . Phone COlumbus 5-2342
CHICAGO, ILL.—8 So. Michigan Ave. . . . . Phone RAndolph 6-8630
TULSA, OKLA.—P. O. Box 730 . . . . . Phone Tulsa 5-5578
HOUSTON, TEXAS—705 Bank of Commerce Bldg. . . . Phone BLackstone 1151
LOS ANGELES, CALIF.—612 So. Flower St. . . . . Phone MAdison 5-1691

IN CANADA: Du Pont Company of Canada Limited—Petroleum Chemicals Division, 80 Richmond St. W., Toronto 1, Ont.
OTHER COUNTRIES: Petroleum Chemicals Export—Nemours Building, 6539—Wilmington 98, Delaware

# Standard mounts that give vibration isolation in the special class

• With Isomode Type 5 isolators, you get an unusual degree of isolation efficiency. They offer equal spring rates in all directions. This means better control of all modes of motion.

Other special advantages of Isomode Mounts: In addition to absorbing equally well troublesome vertical, horizontal and rocking motions, they can be installed at any angle, thereby simplifying design of the suspension. They offer high load capacity in compact sizes. They have plenty of rubber for vibration-absorbing softness . . . yet are stable and self snubbing against shock loads.

These features make Isomode standard mounts suitable for a wide variety of special applications. In the photo above, you see them in an underfloor bus engine suspension. You'll also find these heavy duty mounts in trucks, motor-generator sets, aircraft oil tanks, compressors . . . to name a few.

As a principal source for special-performance mounts available as standard units, MB may have the answer to *your* vibration problem. Contact us and see.

*® Reg. U. S. Pat. Off.*

**BULLETIN NO. 616** gives useful and helpful data on vibration. Send for your copy of our latest revision.

*the* MB *manufacturing company, inc.*

1060 State Street, New Haven 11, Conn.

HEADQUARTERS FOR PRODUCTS TO *ISOLATE* VIBRATION...TO *EXCITE* IT...TO *MEASURE* IT

# McQUAY-NORRIS

## PISTON RINGS

***Since 1910,*** McQuay-Norris has played a leading role in the piston ring field. This background of more than 43 years experience is available to manufacturers who require engineering and production skills of the highest standard.

**McQUAY-NORRIS MFG. CO. • ST. LOUIS 10, MO.**

# WYMAN-GORDON . . .

★ PIONEER in the development of new forging techniques for over seventy years

★ FIRST OPERATOR of a large hydraulic die forging press in this Hemisphere — 18,000 tons in 1946

★ ANNOUNCES the completion of the first forging press in the Air Force Heavy Press Program— 35,000-ton Loewy Press now in production

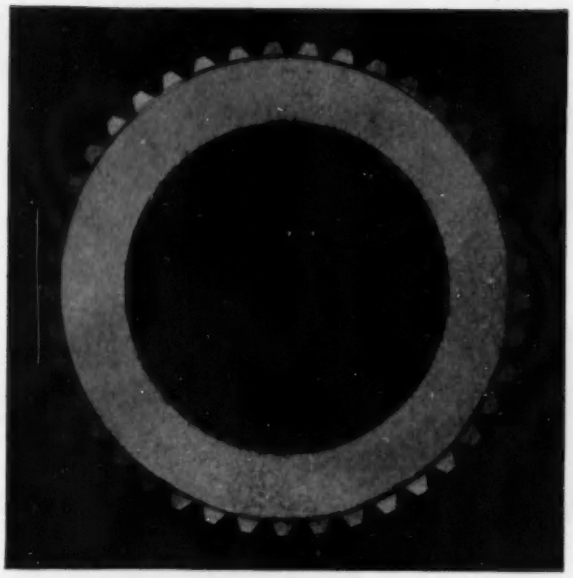
## WYMAN-GORDON CO.

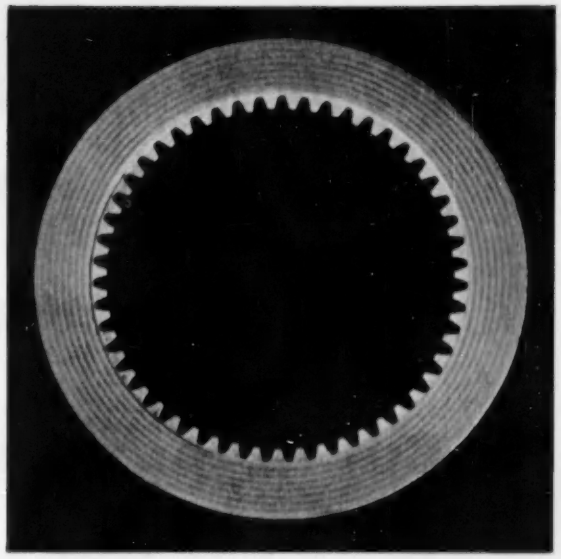
Established 1883

FORGINGS OF ALUMINUM • MAGNESIUM • STEEL • TITANIUM

WORCESTER, MASSACHUSETTS

HARVEY, ILLINOIS DETROIT, MICHIGAN





Clutch plates for modern automatic transmissions incorporate semi-metallic facings (above) or non-metallic facings (right), according to manufacturers' specifications.

for the best in

# automatic transmissions . . .
# moraine friction materials

The range of Moraine friction material formulas is almost limitless. And whether your need is for parts incorporating all-metallic, semi-metallic, or non-metallic friction materials, you can expect more from Moraine . . . because Moraine friction materials meet all the requirements of the application . . . provide superior resistance to heat, wear, and corrosion.

With a long record of performance in Hydra-Matic, Powerglide, and Dynaflow automatic transmissions, Moraine friction materials are finding new uses in heavy-duty truck transmissions, in special military vehicles and equipment, in automotive air conditioning, and in household appliances.

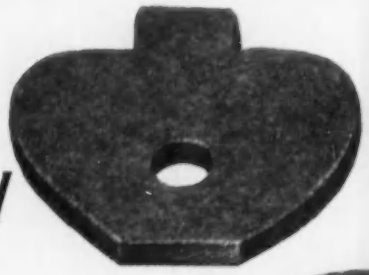
Perhaps Moraine's experience and special abilities with friction materials can be of help to you.

*Other Moraine products include: Moraine-400 bearings, toughest automotive engine bearings ever made—M-100 engine bearings and Moraine conventional bi-metal engine bearings—Self-lubricating bearings—Moraine metal powder parts—Moraine porous metal parts—Moraine rolled bronze and bi-metal bushings—Moraine power brakes—Delco hydraulic brake fluids, Delco brake assemblies, master cylinders, wheel cylinders and parts.*

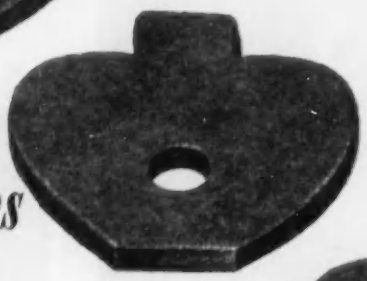
**moraine products**

DIVISION OF GENERAL MOTORS, DAYTON, OHIO

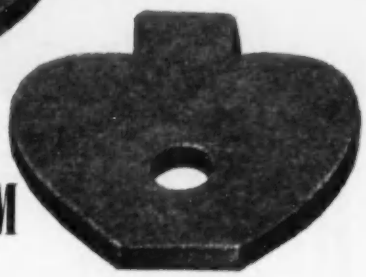
*A Hundred*



*or a MILLION pieces*



*...always* UNIFORM



# Cut to *Your* Precision Demands!

When Western Felt cuts a component part to your specifications, piece after piece is a precision-cut part. You want that kind of uniform precision because the performance of *your* product depends upon it. And because of the peculiar properties of wool felt fibres, especially where the more dense types are specified, it can be processed with amazingly close tolerances. Tolerances as close as a few-thousandths of an inch can be supplied when required.

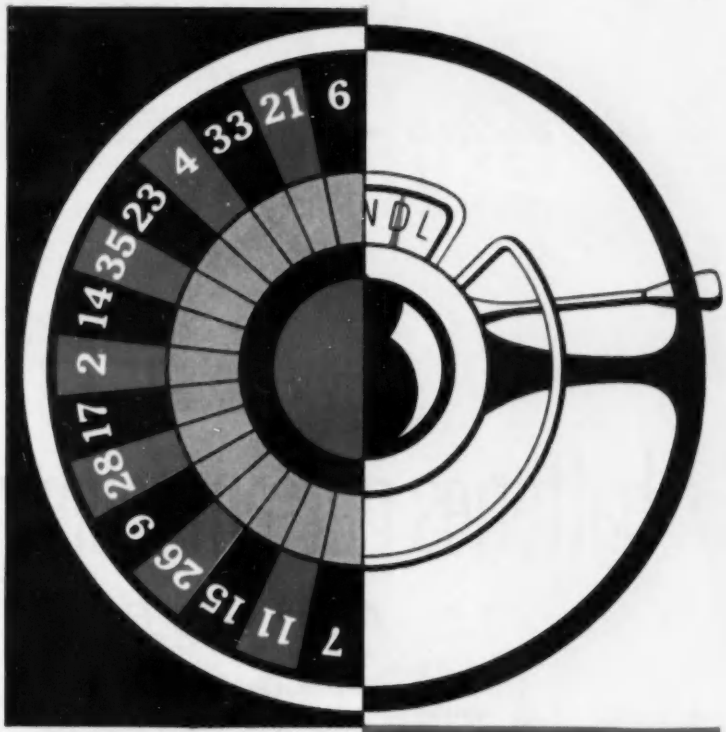
Western Felts are manufactured to the density you require—cut and supplied exactly to your specifications. They resist wear, age and weather...never ravel nor fray. They seal, insulate, absorb sound and vibration, or lubricate...as you wish! Chemically treated, they can be moth-proof, mildew-proof, flame or water resistant.

You name it...specify it...we put the benefits of 54 years of experience back of making a felt component that will meet your specifications. Write today—your inquiry will receive prompt attention.

**WESTERN** *Felt* **WORKS**

4021-4139 W. Ogden Ave., Chicago 23, Illinois
Branch Offices in Principal Cities

Manufacturers and Cutters of Wool Felt




# which is the greater gamble?

**THE ROULETTE WHEEL**

**THE STEERING WHEEL**

The hum of the idling engine gives only the hint of power. He sits behind the wheel. 200 hp. ready to roar into action. The feeling of power is warm . . . exhilarating. His calf muscle tightens. His foot swings down. Instantly, predictably, the engine responds. And with the turn of the wheel . . . he gambles their lives . . . the stakes couldn't be higher.

With a surge of power he moves out of the parking space into traffic. At every stop light, sign or emergency stop he's gambling that his brakes can control all that power.

He's gambling that they won't grab and pitch someone forward . . . won't fade and let the car drift into a cross stream of traffic. He's gambling that the brakes can stop him fast enough . . . often enough . . . without dangerous swerving.

Every day some nice family loses this gamble. Brakes fade or grab, the car swerves or just doesn't stop fast enough.

The greatest single mechanical cause of accidents is brake failure. So why take chances? Better brakes can save lives. Better brakes are here now, ready for cars. They're Auto Specialties Double-Disc Brakes. Double-Disc Brakes automatically keep themselves in adjustment. Don't grab. Don't fade. Stop quicker *at high speeds.* Stop smoother, straighter, quicker, safer . . . *at all speeds.* Auto Specialties Double-Disc Brakes are better brakes.

Auto Specialties Self-Energized Double-Disc Brakes have passed the severe testing of major car factories. Their cost is comparable to that of present automotive brakes. Their adoption will be in keeping with increased horsepower and speed and with the industry's continuing desire to give the American motorist better, safer and more pleasant means of transportation.

For information about these brakes, write for a copy of "THE STOPPING STORY".

## AUTO SPECIALTIES MFG. CO., INC.

**SAINT JOSEPH, MICHIGAN**

Plants also at Benton Harbor and Hartford, Mich., and Windsor, Ont., Canada.
*Manufacturing for the automotive and farm machinery industry since 1908.*

*When fast starts mean lives or dollars –*

# Globe batteries get 'em rolling

## IN A HURRY!

**The same power that helps get emergency vehicles on-the-way fast . . . that cuts costs for heavy equipment operators . . . proves best for today's automotive equipment!**

Whether it's stop, park, then start-again operation in cities or long-but-infrequent use in the country . . . Globe batteries give outstanding service with today's engines. Every Globe battery is the result of continuous product research and development . . . plus the finest, most scientific methods of manufacture.

Add to this Globe's nearly half century of battery-engineering experience . . . Globe's 33 years of building quality batteries for autos, trucks, heavy machinery and army tanks . . . and you know *why* Globe batteries are best for automotive use. Performance records prove that Globe batteries can take it, through rugged working conditions and roughest weather. They prove that Globe batteries are packed with reserve power to keep engines "spinning" until they start.

Take a tip from the experience of others . . . install or specify Globe batteries in your automotive equipment. You're always sure of top performance with Globe . . . the batteries that are built to serve better.

## GLOBE-UNION INC.

MILWAUKEE 1, WISCONSIN

FOR FAST SERVICE THERE ARE 16 GLOBE BATTERY PLANTS — ATLANTA, GA. • BOSTON, MASS. • CINCINNATI, OHIO • DALLAS, TEXAS • EMPORIA, KANSAS • HASTINGS-ON-HUDSON, N. Y. • HOUSTON, TEXAS • LOS ANGELES, CALIF. • MEMPHIS, TENN. • MILWAUKEE, WIS. • MINERAL RIDGE, OHIO • OREGON CITY, ORE. • PHILADELPHIA, PA. • REIDSVILLE, N. C. SAN JOSE, CALIF. • AJAX (TORONTO) CANADA.

**if it's petroleum-powered *there's a* GLOBE-BUILT BATTERY *...right from the start***

MUSKEGON

"UNITIZED"

CHROME-PLATED OIL RINGS

**CSR-200**

First of Muskegon's famous "Unitized" chrome-plated multiple-piece oil rings . . . proved on America's greatest production lines and in the finest cars. Rails and spacer are correctly pre-assembled and "Unitized" to handle like a one-piece ring.

# time-saving

## . . . installs twice as fast as any other multiple-piece ring!

**new CSR-400**

More than ever before, *time is money* on the engine assembly line! That's why Muskegon "Unitized" piston rings have become an important factor in the design of new and better engines . . . they handle like a one-piece ring and install faster than any other multiple-piece ring and without special installation tooling!

Now you can choose from *two* "Unitized" designs: Muskegon's famous CSR-200 chrome-plated oil rings that revolutionized piston ring installation on the assembly line; and the advanced new CSR-400 . . . with a circumferential expander.

Nothing can equal these rings for faster, more economical error-proof installation. Muskegon's patented "Unitizing" process holds the pieces tightly together, in the right order, during installation. This is done with a special adhesive that dissolves during the first engine run, permitting the pieces to separate and function independently of each other. By chrome plating the rails, Muskegon greatly reduces ring wear, bore wear, scuffing and friction.

But prove these important advantages to yourself! Consider Muskegon's CSR-200 or new CSR-400 rings for your engines. Write us today for complete facts.

Most recent new Muskegon development . . . CSR-400 chrome plated oil ring with circumferential expander. All four pieces are "Unitized," a Muskegon exclusive, for easy handling and installation.

Since 1921 . . . The engine builders' source!

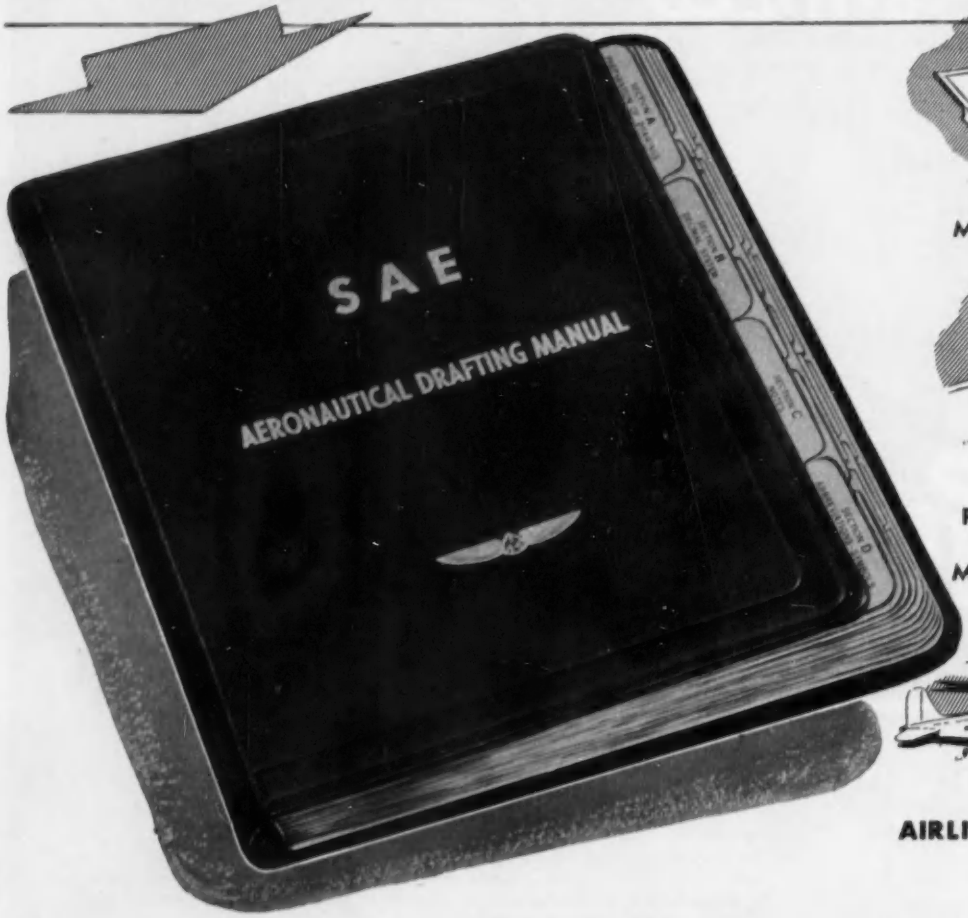
MUSKEGON Piston Rings

DETROIT OFFICE: 521 New Center Bldg. Telephone: Trinity 2-2113

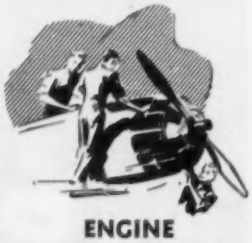
MUSKEGON PISTON RING CO.
MUSKEGON, MICHIGAN
PLANTS AT MUSKEGON AND SPARTA

# This Gives the Answers

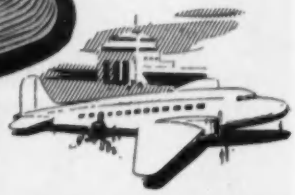
## TO YOUR AERONAUTICAL DRAFTING PROBLEM



AIRCRAFT MANUFACTURERS



ENGINE PROPELLER AND ACCESSORY MANUFACTURERS



AIRLINE OPERATORS

## *The only industry standard on aeronautical drafting practices*

**SAE Aeronautical Drafting Manual includes drafting recommendations for the aircraft and engine manufacturers, the propeller and accessory manufacturers and the airline operators.**

**Fifteen leading engineers, representing all phases of the aeronautical industry, developed this manual. It is receiving wide acceptance, both by the industry and educational fields.**

**NOW AVAILABLE**—A full set of new and revised pages (40) for insertion in the Jan. 1, 1953 Edition of the SAE Aeronautical Drafting Manual originally issued June 1, 1946. **Price $2.00**

**ALSO AVAILABLE**—Complete new revised manual dated May 1, 1954 which includes the latest revision at the following prices: **$4.50 without binder** **$6.50 with leatherette silver printed binder**

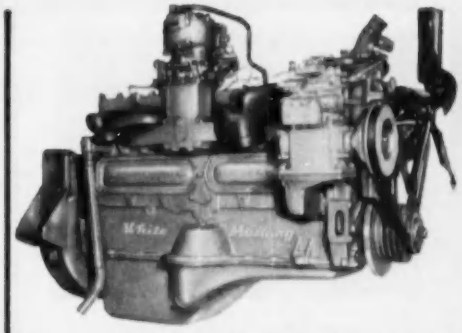
| | | |
|---|---|---|
| **$4.25 without binder** | **For quantity orders, 10 copies or more** | **$6.00 each with binder** |
| **$4.00 without binder** | **For quantity orders, 25 copies or more** | **$5.75 each with binder** |

***ORDER NOW BY WRITING TO THE***

## SOCIETY OF AUTOMOTIVE ENGINEERS

**29 WEST 39th STREET • NEW YORK 18, N. Y.**

More power per pound. A vehicle powered by new White Mustang, benefits from strength, toughness, wear resistance and other properties in vital engine parts made from alloys containing nickel.



This 6-cyl. gasoline unit uses new dome-shaped pistons and combustion chambers. They give 6.4 to 1 compression ratio with excellent detonation control. Exhaust design reduces back pressure. The White Motor Company, Cleveland 1, Ohio.

# White Tractor shows heels

## ...Packs kick of 200 hp White Mustang

A notable development powers this new lightweight payload tractor. The White Mustang engine for hauling bigger payloads.

Equally notable is the way White engineers use nickel alloys. Look at these typical applications.

| | |
|---|---|
| Exhaust Valves, stem & head | Cr.-Ni Alloy (10½ to 12½% Ni) |
| Inlet Valves, stem & head | Alloy steel (0.40 to 0.70% Ni) |
| Connecting rods | SAE 3130 steel (1 to 1½% Ni) |
| Stressed bolts & nuts | SAE 3130 steel (1 to 1½% Ni) |
| Flywheel | Alloy cast iron (0.90 to 1.65% Ni) |
| Cylinder head & crankcase | Alloy cast iron (0.50% Ni) |
| Top piston ring insert | Type 1 Ni-Resist (13-17% Ni) |

### Why do they use nickel alloys?

Take Ni-Resist, for example. It resists heat, corrosion, metal-to-metal wear and galling. Its control of ring groove wear not only saves your oil, but stops needless power loss due to "blow by." Thus, you get more mileage. And you also enjoy longer piston life with less maintenance. Records prove this.

In a similar way, the other components containing nickel help to improve Mustang performance.

Properties of nickel alloys may be controlled to meet both fabricating and service demands. That's why it will pay you to specify them for your products.

*Make use of our wide experience in solving all sorts of metal problems. Whatever the difficulty facing you, send us details. We'll be glad to give you our suggestions.*

INCO TRADE MARK

**Write for:** List A of available publications. Its simple form makes it easy for you to outline your problem.

**THE INTERNATIONAL NICKEL COMPANY, INC.** 67 Wall Street New York 5, N.Y.

**At Kenton, Ohio**—in the world's largest, most modern trailer axle plant—a hydraulic press (right) exerts a 50-ton pressure near the end of every TDA Trailer Axle, bends the tube next to the seams to *insure* strong welds, no weak spots, and complete absence of flaws.

# WE BEND TRAILER AXLES

## ...to insure that all welded super-strong!

**Another example of TDA hidden quality—typical of the ends to which we go for greater highway safety—proof in advance that TDA Trailer Axles can take it!**

**Double trouble!** Yes, TDA Trailer Axles are torture-tested at *both* the Kenton, Ohio plant—and the famous Timken-Detroit indoor proving ground in Detroit!

The Detroit "Torture Chamber" is a multi-thousand-acre proving ground condensed into one room. Here, our engineers can subject stock axles and gearing *indoors* to any outdoor operating condition. Put over 50 years' experience gained in building axles for trucks, buses, trailers, farm machinery to work for you.

Result? Far greater highway safety, longer axle life, reduced maintenance, repairs and downtime; lowered operating costs. *No wonder Timken-Detroit Axles are the choice of leading manufacturers and operators.*

**For your own protection and safety specify Genuine TDA Equipment Parts!**

Take no chances with substitute replacement parts. For longer axle life—for greater operating safety—insist upon genuine Timken-Detroit axle and brake parts, identical to your axles' original equipment.

For a dependable factory-type job, to cut labor and adjustment costs . . . *order* your replacement parts by TDA number from your trailer manufacturer.

# TDA...the *Lightest* trailer axle on the market...and the strongest!

Proved far stronger, more rugged and safer in all-out "Torture Chamber" tests, TDA Trailer Axles are also many pounds lighter than any competing axles on the market today. Weight saving is possible through the use of TDA lightweight, pressed steel brake shoes, up to 50% lighter, and stronger, too.

Other hidden quality features that increase TDA life and performance are forged alloy steel spindles, cam roller mountings in Nylon bushings, machined cam head, cleaner cut splines and self-aligning camshaft support brackets. Good reasons leading manufacturers and operators specify TDA.

## Heat and stress relief treatment for greater strength!

Note the greater extent and depth of heat treatment given this TDA Cam and Seamless Tube. Tube is heat-treated for the *full length*. And, the camshaft is *completely* heat-treated; not just the head. An important ingredient of TDA superiority.

A stress relief treatment is given *every* tube to relieve any stresses created during machining and welding.

TDA Spindles forged of alloy steel have higher rockwell hardness than any other axle spindle on the market.

# WITH 50-TON PRESSURE

## *seams are*

**TIMKEN Detroit AXLES**

TIMKEN-DETROIT AXLE DIVISION
ROCKWELL SPRING AND AXLE COMPANY
DETROIT 32, MICHIGAN

The Accepted DA Standard

TRADE MARK REGISTERED

MEMBER TRUCK-TRAILER MANUFACTURERS ASSN. TTMA

**ONLY TDA BRAKES give all these tested advantages!**

- Brake shoes made of steel save up to 40 pounds per axle . . . give strong braking action with no distortion.
- Patented liner shape—thickest where wear is greatest.
- Liners riveted on—no chance of movement on shoe.
- Liners circle-ground to cover all efficient braking area of shoe.
- Rustproofed anchor pins locked in. Ends of pin sealed against foreign matter.
- First with self-aligning camshaft housings.
- Cam rollers heat-treated to roll smoother, wear longer.
- First with all-Nylon camshaft bushings.
- Compare similar products part for part and prove to yourself that TDA brakes incorporate the finest quality materials, skilled workmanship and advanced design.

# *Creative Engineering Opportunities with Republic*

## *Research*

**Research Engineer—Hydraulic Controls**

B.S. degree in mechanical or aeronautical engineering with experience on aircraft hydraulic systems. Work involves mechanical and hydraulic problems such as control system frequency response, hydraulic system and control valve characteristics and high temperature fluids, packings, pumps and related components. Must be capable of planning and conducting test programs, designing special test equipment, maintaining contact with vendors and design personnel.

**Senior Research Engineer—Servomechanisms**

B.S. degree in mechanical or aeronautical engineering with a minimum of 3–5 years experience in testing or design of servo-mechanism controls. Must be capable of conducting airplane autopilot and controls system testing and analyses. Familiar with all phases of oscillograph instrumentation. Vibrations experience considered.

## *Stress Section*

**Senior Stress Analysis Methods Engineer**

Engineer, B.S. or M.S. in aeronautical or civil engineering, with advanced mathematics background and with a minimum of 3 years experience in airframe stress analysis, or structural methods.

*Please address complete resume, outlining details of your technical background, to:*

Mr. R. L. Bortner
*Administrative Engineer*

**REPUBLIC AVIATION**
FARMINGDALE, LONG ISLAND, NEW YORK



**Want One For Your Lapel?**

# An SAE Emblem

- **Distinguishes you as an SAE member**
- **Is an attractive gold-filled clutch-back pin**
- **Costs only $1.50**
  plus
  15¢ Federal tax for delivery in the United States and 5¢ sales tax for delivery in New York City

ACTUAL SIZE

GOLD on BLUE ..... Member Grade
GOLD on RED ..... Associate Grade
GOLD on WHITE ..... Junior Grade

Society of Automotive Engineers
29 West 39 St., New York 18, N. Y.

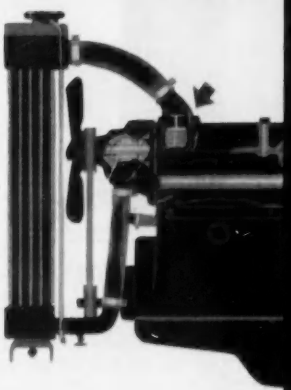
Please send me an SAE emblem. Enclosed is my check for $..... ($1.50 plus applicable taxes). Grade of membership (please check)

☐ Member ☐ Associate ☐ Junior

Name .....
(PLEASE PRINT)

Address .....

# "TRAFFIC COP" FOR YOUR COOLING SYSTEM!



The Harrison thermostat directs the "stop and go" of water flow through the engine cooling system. Accurate and dependable—it automatically maintains *right* temperature for top performance.

## Another important Harrison assignment!

*Harrison's on the "heat beat"!* Today's modern high-compression engine demands *the last word* in accurate, dependable thermostat control! That's why leading car and truck manufacturers specify *Harrison* thermostats! In fact, all Harrison heat control products—from helicopter engine oil coolers to passenger car air conditioning systems—are *engineered* to assure dependable, economical service! And every Harrison heat control product is backed by more than 44 years of research and manufacturing experience. If you have a hot or cold problem, look to Harrison for the answer!

HARRISON RADIATOR DIVISION, GENERAL MOTORS CORP., LOCKPORT, N. Y.

HARRISON

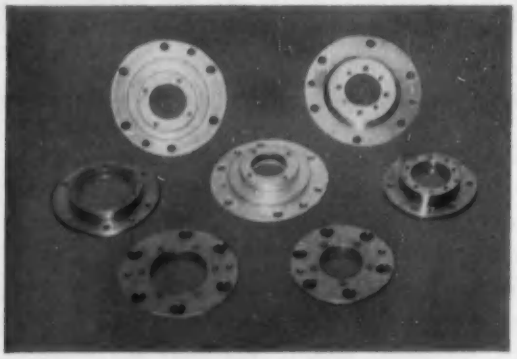
TEMPERATURES MADE TO ORDER

**SIMPLEX PISTON RING MFG. CO.**
*Established in 1923*

**HIGH SPEED SHAFT SEALS and PISTON RINGS for both JET and RECIPROCATING AIRCRAFT ENGINES.**

**ORIGINAL EQUIPMENT IN ALLISON, PRATT & WHITNEY, WRIGHT and other leading AIRCRAFT ENGINES**

## HIGH SPEED SHAFT SEALS



**Write us for further information**

**FACTORIES AT:**

**75 N. E. 74th St., Miami 38, Fla.**

**SIMPLEX PISTON RING MFG. CO.**
12301 Bennington Ave., Cleveland 11, Ohio

A-97

# Precise PRESSURE Measurement

**Sensitivity 0.2%**

W&T PRECISION LOW PRESSURE GAUGE—FA-141

Ranges: All ranges from 0-10 inches water to 0-30 inches Hg.

*Write today for Publication No. TP-27-A*

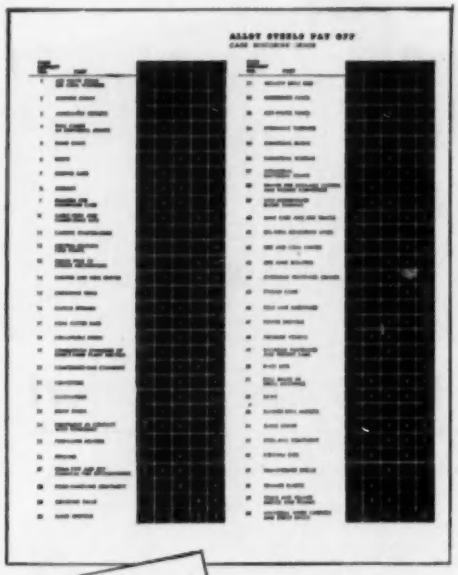
**WALLACE & TIERNAN**
ELECTRICAL MECHANISMS AND PRECISION INSTRUMENTS
Belleville 9, New Jersey . . . Represented in Principal Cities
*In Canada, Wallace & Tiernan Products, Ltd.—Toronto*

**ENGINEERS:** • RESEARCH • DESIGN • DEVELOPMENT

The Automotive Engineering Division of Chrysler Corporation in Detroit has attractive openings for men with or without experience in the following categories:

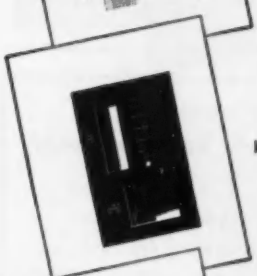
- Automotive Gas Turbine Research and Development
- Advance Chassis Design—Particularly Suspensions, Accessory Drives and Brakes
- Ordnance Materiel Design, Development and Field Representation
- Automotive Structures—Development of Bodies, Frames, Seats and Hardware

***Address inquiries to:*** **L. C. BETTEGA**
**Chrysler Engineering, P. O. Box 1118, Detroit 31, Michigan**

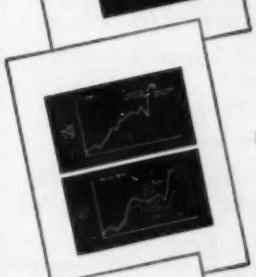


60 fully documented case histories

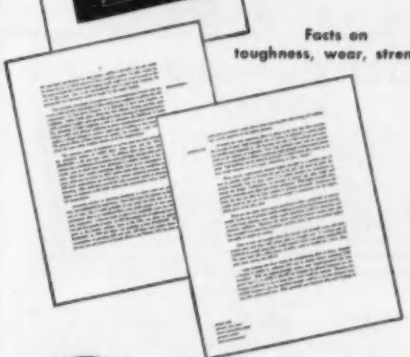
Facts on maximum pay load



Facts on lower operating costs



Facts on lower corrosion rate



Facts on toughness, wear, strength

**CLIMAX MOLYBDENUM COMPANY, Dept. 16**
**500 Fifth Avenue, New York 36, N. Y.**

Please send me the 208-page handbook
"Alloy Steels Pay Off"

Name_____

Company_____

Title_____

Address_____

MAIL THIS TODAY

# If you use steels, here's the handbook you should have

This fact-packed handbook is a must for you if you use steel. Here, in completely documented form, you'll find how the use of alloy steels adds economies, increases service life, offers many other advantages.* Cost-conscious executives will find the full story on these economies of alloy steel in the first section of the handbook. Designers and metallurgists will find the advantages of alloy steels in the 60 case histories. Get your copy today. Climax Molybdenum Company, 500 Fifth Avenue, New York 36, N. Y.

MSS-18

***Advantages of ALLOY STEELS**

- longer life
- greater pay load
- lower operating costs
- greater safety
- less maintenance

# CLIMAX MOLYBDENUM

# New "Monarch"

BY MILSCO *America's Leading Seat Specialists*

FOR MANUFACTURERS OF MOBILE EQUIPMENT

No. 344 *With Or Without Fore And Aft Attachment*

## ★4 Point Body Comfort

The new Milsco "Monarch" features deep cushion comfort with full 4-point body support. Ruggedly built; attractively styled. Designed for stepped-up work efficiency on many types of mobile equipment. (Sold to equipment manufacturers only.) Write for catalog on your company letterhead.

**MILSCO MFG. CO.**
2758 N. THIRTY-THIRD STREET
MILWAUKEE 45, WISCONSIN

LAMINATED PLYWOOD BACK AND SEAT | GENUINE OR ARTIFICIAL LEATHER | TUBULAR STEEL FRAME | FOAM RUBBER OR LATEX COVERED SISAL | SPECIAL LONG LIFE COIL SPRINGS | Milsco MILWAUKEE

## *Immediate Openings*

Research & Development Engineers
Electrical Engineers
Tooling Engineers
Ordnance Engineers
*Mechanical Designers*
*Ballistics*
*Servo-Mechanisms*
*Intricate Machine Designers*
Mechanical Engineers
Plant Engineers
Impact Extrusion Engineers

**These challenging positions offer unlimited opportunities for professional advancement**

***Excellent housing for city, suburban, or country living***

**Your correspondence will be kept in complete confidence**

***Send your resume to Administrative Engineering Dept.***

## HARVEY
MACHINE CO., INC.
**Torrance, California**
**15 miles south of Los Angeles**

*40 years of engineering and production leadership in the west*

**8 NEW and 12 REVISED**
**Aeronautical Standards & Recommended Practices**
**were issued**
**December 15, 1954**

**30 NEW and 37 REVISED**
**Aeronautical Material Specifications**
**were issued**
**March 1, 1955**

For further information please write

**SOCIETY OF AUTOMOTIVE ENGINEERS, INC.**
**29 WEST 39 STREET, NEW YORK 18, N. Y.**

## FLEET ENGINEER WANTED

**The Tennessee Valley Authority needs a competent Fleet Engineer in its Transportation Branch located at Chattanooga, Tennessee.**

**The salary is $5625 per year for a 40-hour week, with automatic within-grade increases for satisfactory service. Vacation, sick leave, and retirement benefits. This is diversified work including maintenance engineering, field observation, shop operations, and limited test and experimental work on automobiles, construction and marine equipment, and airplanes.**

**Applicants must have a bachelor's degree in Automotive Engineering, Mechanical Engineering, or Electrical Engineering; and three years of practical experience in fleet, service, or maintenance engineering.**

**Interested candidates should write to Tennessee Valley Authority, Division of Personnel, Knoxville, Tennessee.**

# performance proven *by millions of installations*

- ***"No Kick-Out" feature wins overwhelming approval from car, truck and tractor manufacturers***

Although a comparatively new advancement in starter drive design, the Bendix* Folo-Thru Drive has already proven itself in millions of installations to be the most efficient starting equipment under all operating conditions.

The Folo-Thru type is specially designed to follow thru the weak explosions until the engine actually runs on its own power. Thus, quicker and more dependable starts are assured even under the most extreme weather conditions.

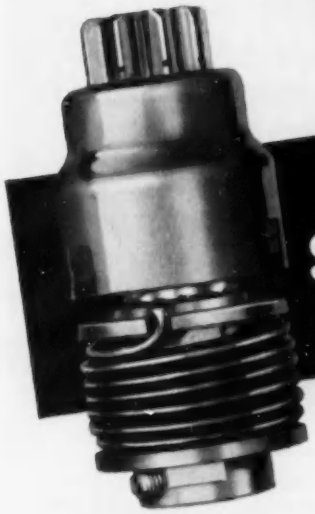
You're right from the start when you specify Bendix Folo-Thru Starter Drive.

**ECLIPSE MACHINE DIVISION OF** Bendix AVIATION CORPORATION

**ELMIRA, NEW YORK**

**Export Sales: Bendix International Division, 205 East 42nd Street, New York 17, N. Y.**

## Bendix folo-thru starter drive



**costs less**—*Like the millions of Bendix Starter Drives manufactured for the industry, the new Folo-Thru Drive requires no actuating linkage, and the less expensive solenoid may be placed in any convenient position. Result is lower installation and maintenance costs. Complete detailed information is available on request.*

*REG. U.S. PAT. OFF.

Bendix* Folo-Thru Starter Drive Bendix* Automotive Electric Fuel Pump Stromberg* Carburetor

# SAE

## offers the new ....

# BLAST CLEANING MANUAL

**SP-124**

- A BRAND NEW SAE MANUAL—the Blast Cleaning Manual—SP-124, newly listed with our publications, is priced at $2.00 per copy to SAE members and $4.00 per copy to nonmembers; quantity prices upon request.

- A "HOW-TO-USE-IT" BOOK—SAE Blast Cleaning Manual, the work of Division XX—Shot Peening, Iron & Steel Technical Committee, instructs engineers, designers, and shop men in blast cleaning "know how."

- A FIRST COMPLETE STORY—the Manual fully discusses blasting abrasives, blast cleaning machines, production procedures and process specifications; includes 36 illustrations and 3 tables.

ORDER BLANK

Society of Automotive Engineers
29 West 39th Street
New York, New York

Add 3% city sales tax for deliveries in N. Y. C.

Please send me .... copies of SP-124 (Check) (Cash) (Coupons)

Name _____

Company Name _____

Company Address _____

# Imperial

THE *Finest* TRACING CLOTH

Imperial is known in drafting rooms all over the world as the traditional quality tracing cloth.

With the background of decades of experience, its makers have pioneered in modern improvements to maintain Imperial as the finest tracing cloth made.

---

Over 85% of the torque wrenches used in industry are

## STURTEVANT TORQUE WRENCHES

*Read by Sight, Sound or Feel*

- Permanently Accurate
- Practically Indestructible
- Faster—Easier to use
- Automatic Release
- All Capacities

*in inch grams*
*...inch ounces*
*...inch pounds*
*...foot pounds*

*Every manufacturer, design and production man should have this valuable data. Sent upon request.*

P.A. STURTEVANT CO.
ADDISON QUALITY ILLINOIS

---

## when old-fashioned fasteners won't work

Specify

**BANC-LOK** by *BOOTS*

**New, self-locking threaded Inserts and Tapped Holes.**

Designed primarily for materials too thin or too soft to sustain threads.

**BANC-LOK** threaded Inserts are ideal for blind fastening, economical, reusable and eliminate extra locking devices.

**BANC-LOK** Tapped Holes are designed for sheet materials too thin to tap.

**BANC-LOK** Inserts and Tapped Holes require no special tools . . . simply push into round holes. Available in aluminum alloy, **BANC-LOK** Inserts may be ordered in any size and material.

*Write for samples and catalogue.*

AN APPROVED

*BOOTS Aircraft NUT CORPORATION*

BANC-LOK DIVISION

539 NEWTOWN TURNPIKE · NORWALK, CONNECTICUT

# + INDEX TO ADVERTISERS +


**A**

AC Spark Plug Div., General Motors Corp. ..... 151
Aeroquip Corp. ..... 145
Aetna Ball & Roller Bearing Co. Div. of Parkersburg-Aetna Corp. ..... 131
Airesearch Manufacturing Co. .. 140
Allied Products Corp. ..... 149
American Chemical Paint Co. .. 100
American Felt Co. ..... 196
Auto Specialties Mfg. Co., Inc. .. 179

**B**

Bendix Aviation Corp. Bendix Products Div. (General Sales) ..... 16
Eclipse Machine Drive Div. ..... 191
Bendix Westinghouse Automotive Air Brake Co. ..... 167
Bethlehem Steel Co. ..... 172
Blood Brothers Machine Div. ..... 119
Boots Aircraft Nut Corp. ..... 193
Borg & Beck Div., Borg-Warner Corp. ..... 118
Borg-Warner Corp. ..... 165
Bower Roller Bearing Co. ..... 171
Bundy Tubing Co. ..... 10, 11

**C**

Chrysler Corp., Engineering Recruiting ..... 188
Clark Equipment Co. ..... 163, 164
Climax Molybdenum Co. ..... 189
Convair, A Div. of General Dynamics Corp. ..... 106

**D**

Delco-Remy Div., General Motors Corp. ..... 154, 155
Detroit Steel Products Co. (Automotive Div.) ..... 112
Dewey & Almy Chemical Co., Div. of W. R. Grace & Co. ..... 2
Dole Valve Co. ..... 114
du Pont de Nemours & Co., Inc., E. I. (Petroleum Chemicals Div.) 173
du Pont de Nemours & Co., Inc., E. I. (Organic Chemicals Dept.) 159

**E**

Eagle Pencil Co. ..... 153
Eaton Mfg. Co., Axle Div. ..... 14
Eaton Mfg. Co., Valve Div. ..... 147
Electric Auto-Lite Co. ..... 9

**F**

Fafnir Bearing Co. Inside Back Cover
Fasco Industries, Inc. ..... 108
Federal-Mogul Corp. ..... 137
Fram Corp. ..... 129
Fuller Mfg. Co. ..... 105

**G**

General Plate Div. Metals & Controls Corp. ..... 12
Globe-Union, Inc. ..... 180
Goodyear Tire & Rubber Co., Inc. ..... 7
Great Lakes Steel Co. ..... 101

**H**

Harrison Radiator Div., General Motors Corp. ..... 187
Harvey Aluminum, A Div. of Harvey Machine Co., Inc. ..... 190
Hooker Electrochemical Co. ..... 150
Hyatt Bearings Div., General Motors Corp. ..... 99

**I**

Imperial Pencil Tracing Cloth .. 193
International Nickel Co., Inc. .. 183

**J**

Johnson Products, Inc. ..... 97

**K**

Keller Tool Div. of Gardner-Denver Co. ..... 8
Keuffel & Esser Co. ..... 170
Koldflo Div., Mullins Mfg. Co. .. 123

**L**

Lipe Rollway Corp. ..... 162
Liquidometer Corp. ..... 143
Lisle Corp. ..... 124

**M**

McQuay-Norris Mfg. Co. ..... 175
Marvel-Schebler Products Div., Borg-Warner Corp. ..... 133
MB Mfg. Co., The ..... 174
Mechanics Universal Joint Div. Borg-Warner Corp. ..... 6
Menasco Mfg. Co. ..... 157
Micromatic Hone Corp. ..... 166
Midland Steel Products Co. .. 126, 135
Milsco Mfg. Co. ..... 190
Moraine Products Div., General Motors Corp. ..... 177
Morse Chain Co., Borg-Warner Corp. ..... 115
Muskegon Piston Ring Co. ..... 181

**N**

National Metal Abrasive Co. ..... 110
New Departure Div., General Motors Corp. ..... 1

**P**

Packard Electric Div., General Motors Corp. ..... 144
Palnut Co. ..... 98
Park Drop Forge Co. ..... 102
Parker Appliance Co. ..... 146
Perfect Circle Corp. Inside Front Cover
Pesco Products Div., Borg-Warner Corp. ..... 107
Precision Rubber Products Corp. ..... 3

**R**

Raybestos-Manhattan, Inc. .. 160, 161
Republic Aviation Corp. ..... 186
Rochester Products Div., General Motors Corp. ..... 141
Rockford Clutch Div., Borg-Warner Corp. ..... 113
Rohr Aircraft Corp. ..... 120, 158
Ross Gear & Tool Co. ..... 5
Ryan Aeronautical Co. ..... 109

**S**

Hotel Schroeder ..... 188
Sealed Power Corp. ..... 103
Simplex Piston Ring Mfg. Co. .. 188
Spencer Thermostat Div. Metals & Controls Corp. ..... 134
Spicer Mfg. Div. of Dana Corp. ..... 168, 169
Sterling Aluminum Products, Inc. ..... 4
P. A. Sturtevant Co. ..... 193

**T**

Tennessee Valley Authority ..... 190
Thompson Products, Inc., Valve Div. ..... 152
Timken Detroit Axle Div. Rockwell Spring & Axle Co. ..... 184, 185
Timken Roller Bearing Co. Outside Back Cover
Tinnerman Products, Inc. ..... 111
Torrington Co., The (Needle Bearings) ..... 142
Tung-Sol Electric, Inc. ..... 132
Twin Disc Clutch Co. ..... 128

**U**

U. S. Rubber Co., Engineered Rubber Products ..... 156
U. S. Rubber Co., Naugatuck Chemicals ..... 117, 138, 139
Upholstery Leather Group ..... 195

**V**

Van Der Horst Corp. of America ..... 116
Vickers, Inc. ..... 125
Victor Mfg. & Gasket Co. ..... 121

**W**

Wagner Electric Corp. ..... 136
Waldes Kohinoor, Inc. ..... 127
Wallace & Tiernan Products, Inc. ..... 188
Westinghouse Electric Corp., Atomic Power Div. ..... 130
Western Felt Works ..... 178
S. S. White Mfg. Co., Industrial Div. ..... 122
Wyman-Gordon Co. ..... 176

**Y**

Yates-American Machine Co. .. 104
Young Radiator Co. ..... 191

"I recommend genuine Leather because people don't expect to pamper Pontiacs"

*R. A. Johnson*
*Dick Johnson Motors*
*5940 No. Western Ave.*
*Chicago 45, Illinois*

"The Pontiac is built for service and performance—truly a carefree car. And the most carefree upholstery material I know of is genuine leather. It laughs off scuffs and scratches—and its finish actually improves with use, taking on a rich gleam. That's why I urge customers to choose the models upholstered in genuine leather—they get the most for their money that way."

Mild soap and water is all that is needed to keep genuine leather upholstery looking as good as new—or better.

*Only genuine leather wears as well as it looks.*

YOU CAN GET THE FACTS THAT PROVE LEATHER IS BEST. Send the coupon today for "All About Genuine Leather" (free), showing results of tests by a famous impartial testing company.

THE UPHOLSTERY LEATHER GROUP, INC., Dept. SAE-2
141 East 44th Street, New York 17, N. Y.

Please send me, free, your "All About Genuine Leather".

Name_____

Firm_____

Address_____

City_____ Zone_____ State_____

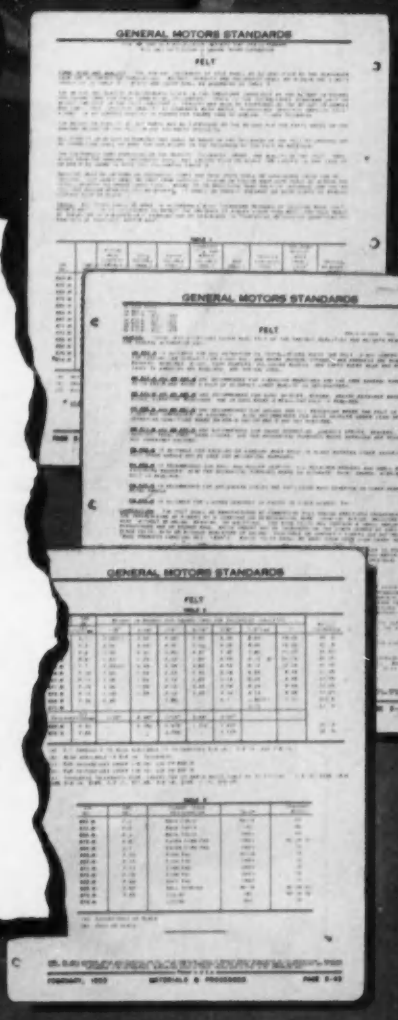
THE UPHOLSTERY LEATHER GROUP, INC. 141 East 44th St., New York 17, N.Y. • 99 West Bethune, Detroit 2, Mich.

# 50,000,000 cars mean over a Billion Felt Parts!

These General Motors Felt Standards were the first felt specifications to be written. Their successful development in 1920 was a part of the GM program aimed at improving the quality and performance of GM products. GM wanted to know what felt could do, how it could help make cars better, whether felt quality could be controlled. American Felt was given the privilege of collaboration. Together we studied what types of felt were most suitable for each application, and what new uses could be developed. As a result, GM was able to standardize its felts. This benefited not only GM and American, and the felt industry, but the automotive field as well, because the GM Standards later became the basis for the S.A.E. Felt Standards.

Today there are over 80 felt parts in an automobile, and others in trucks, tractors, home electric plants, washing machines, and so on. Felt wicks supply oil; felt seals retain lubricants, filter out foreign particles and water; felt channels guide and protect windows; felt prevents chafing noises and rattles. In many unseen ways, GM standard felts serve us all. The specifications first developed in 1920 are still used daily, still guide designers, engineers, and purchasing personnel, making it possible for felt to be selected, specified with care, and bought with as much accuracy and assurance as any other engineered material.

Many factors entered into the design and production of cars so good that 50 million have been made by GM to meet public demand. Standardized felt is but one. American, and the felt industry as a whole, is glad to contribute to the economy, safety, reliability and comfort of General Motors cars.




**American Felt Company**

TRADE MARK ®

GENERAL OFFICES: P. O. BOX #5, GLENVILLE, CONNECTICUT.
SALES OFFICES: New York, Boston, Chicago, Detroit, Cleveland, Rochester, Philadelphia, St. Louis, Atlanta, Dallas, San Francisco, Los Angeles, Portland, Seattle, Montreal. — PLANTS: Glenville, Conn.; Franklin, Mass.; Newburgh, N. Y.; Detroit, Mich.; Westerly, R. I. — ENGINEERING AND RESEARCH LABORATORIES: Glenville, Conn.

*An attitude and aptitude for solving bearing problems . . .*

**Fafnir Super-Precision Ball Bearing** for main rotor shaft of jet engine

# FAFNIR

BALL BEARINGS

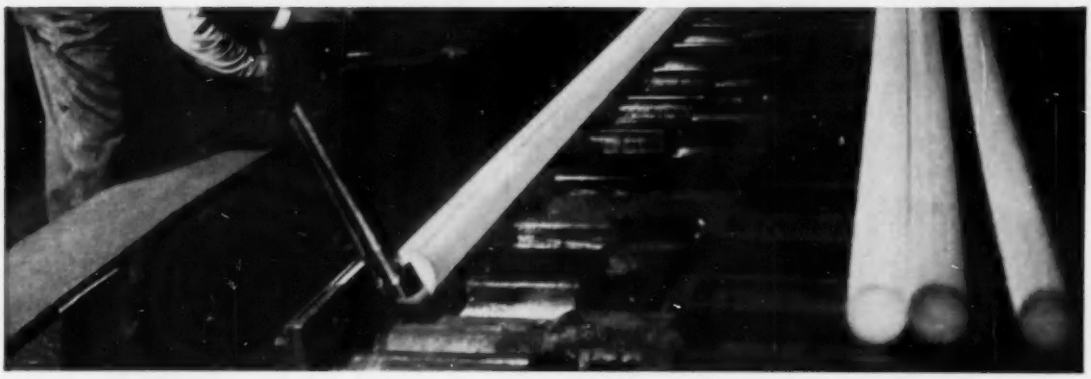
*In this man-made inferno,* the jet engine, there is no place for parts that "can't take it." Rapid and wide temperature changes distort them. Without proper compensation, they get out of line, resulting in vibration and wear.

For jet engine rotor shafts, Fafnir builds super-precision bearings with measurements made to millionths and finishes to microinches. They're specifically designed to compensate quickly for distortion and to maintain shaft rigidity under blast furnace conditions.

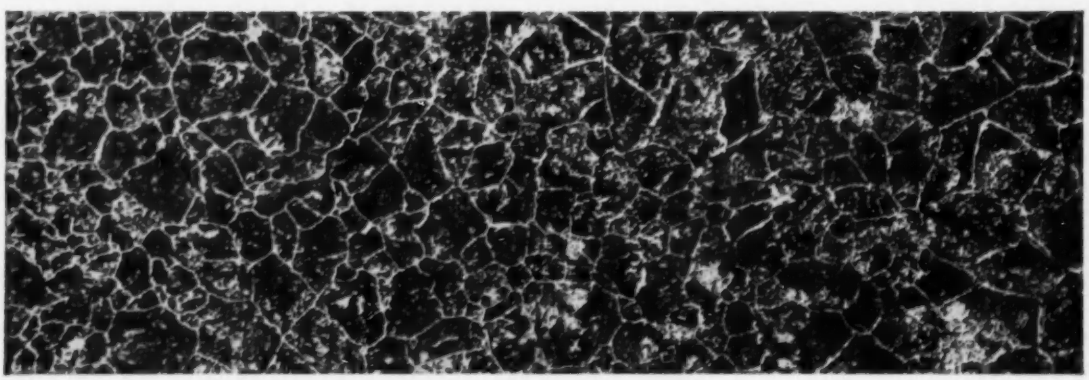
Such bearings can come only through collaboration with aircraft engineers and designers. Perhaps similar collaboration can help you solve a bearing problem involving temperature extremes. The Fafnir Bearing Company, New Britain, Conn.

MOST COMPLETE LINE IN AMERICA

# INDIVIDUAL HANDLING...one good reason



## TIMKEN® forging steels give uniform



## grain size order after order

THERE are good reasons for the uniform grain size in every piece of Timken® forging steel, as shown in the photomicrograph above. And good reasons, too, why you get the grain size you want order after order.

Your order for Timken forging steels is handled individually in our mills and we target conditioning procedure to your particular forging requirements. In the top photo, a billet is stamped to identify the heat and ingot it came from—one way we can make sure you get uniform grain size from shipment to shipment.

Uniform grain size after heat treatment is assured by spectrometric or microscopic examination of every heat. The result—you can be sure that forgings made from Timken forging steels have uniformly high ductility and resistance to impact.

You have fewer furnace temperature adjustments when you use Timken forging steels. Every lot responds uniformly to heat treatment because every lot has the same physical and chemical properties. Always specify Timken forging steels. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING